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FRESH AIR AS A SPECIALTY

IN THE EQUIPMENT OF THE EMPORIUM DEPARTMENT STORE, ST. PAUL, MINN.

PROVISION OF FRESH AIR as one of the conveniences offered to patrons has proved in the case of the Emporium a good investment, not only because in our day when we are so beset by germs, the idea of shopping where we are protected from these tormentors is attractive but also because the plentiful supply of fresh, clean, humidified air induces to alertness in clerks and attendants and quick action on the part of customers. Jaded weariness is a sure accompaniment of foul air and the employes in this store are unanimous in saying that they feel no greater weariness after a day's work in the constantly renewed atmosphere of the store than they have after a few hours where no such provision has been made.

Recognizing the awakening interest of the public in good ventilation, this store has been widely advertised by the proprietors under the caption "The Emporium—The Fresh Air Store."

The first thought in laying out the mechanical equipment of this building was to provide plenty of ventilation and plenty of light, so that in laying out the plant the consulting engineer, Charles L. Pills-

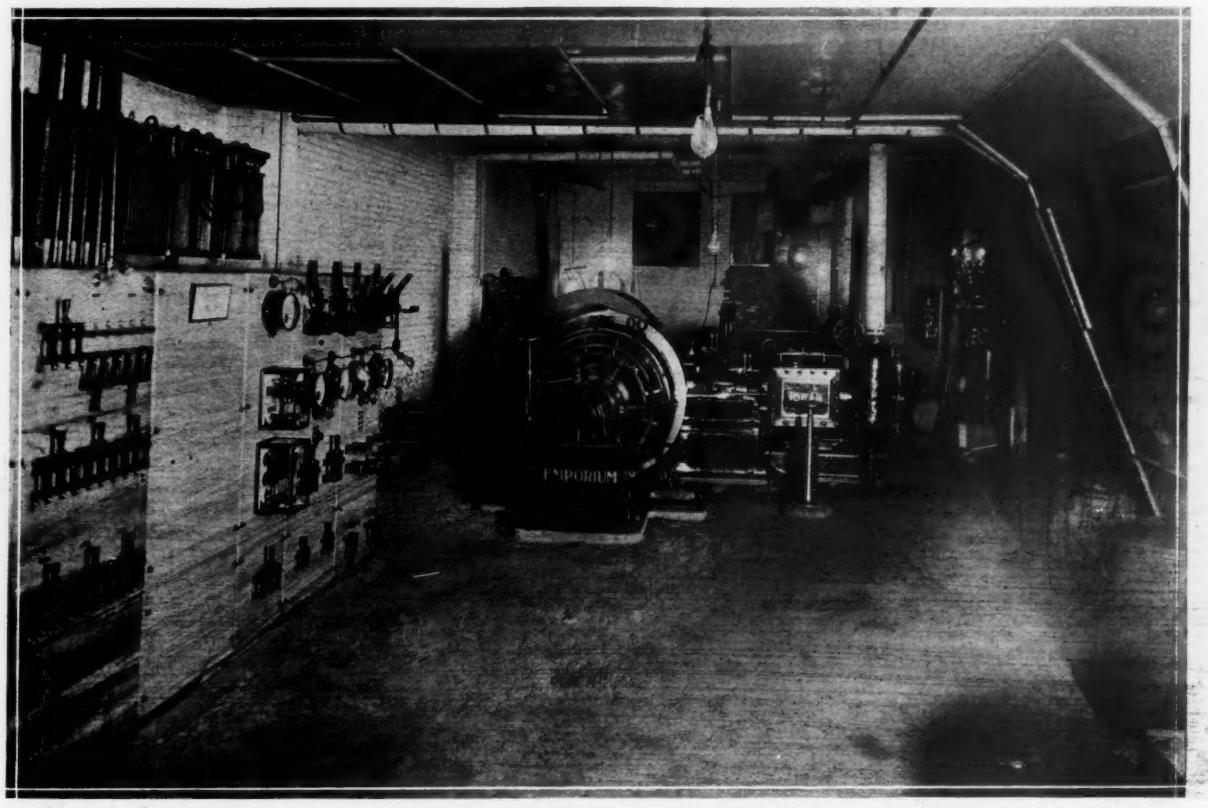


FIG. 1. LOOKING INTO THE EMPORIUM ENGINE ROOM FROM THE STORE

bury, paid special attention to these features and has embodied many novel conveniences which add to the attractiveness of the store.

Ventilation

GIVING attention first to the ventilation system, the start is made at the air intake, which is a shaft located in the rear wall of the building. This is arranged to partially re-circulate the air from the second and third floors and also to take in a plentiful supply

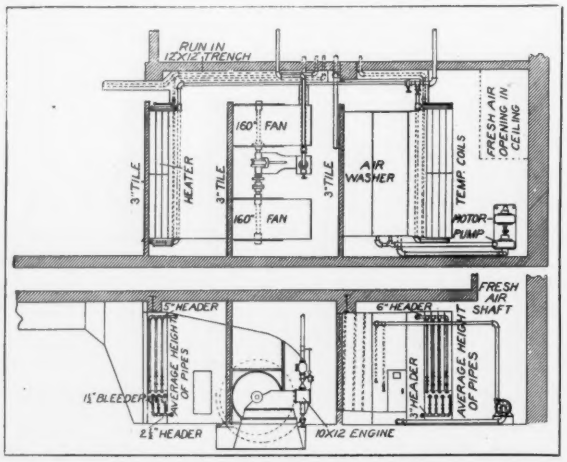


FIG. 3. DETAILS OF AIR WASHING AND HEATING ARRANGEMENT

of fresh air by means of an outside damper with louvre openings at the level of the third floor.

The lower end of this shaft discharges the air through a grating into the fan chamber in the basement, as indicated in the detail, the air being drawn by 2 motor-driven fans through the tempering coils and air washer. The laundered air is then forced through the heating coils and into the distributing flues, which are carried on the ceiling of the basement and which distribute the air as shown on the basement plan to all parts of the basement and first floors.

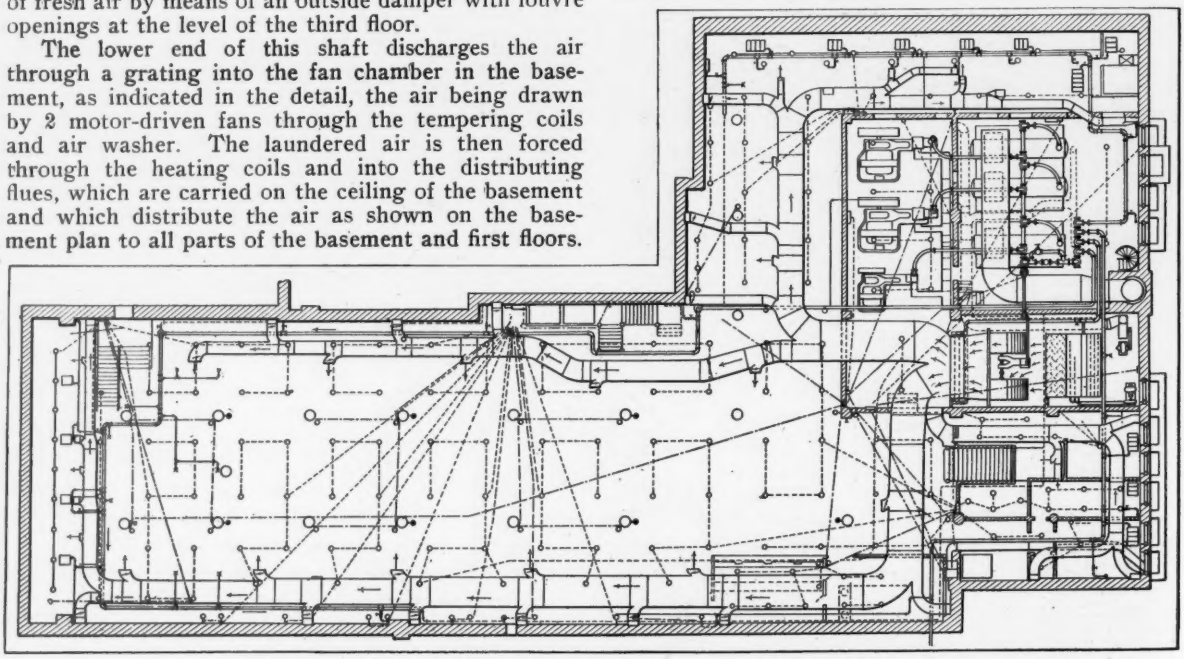


FIG. 2. PLAN OF BASEMENT SHOWING VENTILATING SYSTEM AND ARRANGEMENT OF PLANT

Distribution to the basement is by means of outlets looking toward the center of the building and controlled by dampers. The distribution to the first floors is by means of branches which turn back against the wall, pass up to 8 ft. above the level of the first floor and then turn inward above the shelving, as shown in the detail.

Deflectors are put into the elbow ahead of the discharge, so that the air will be distributed uniformly from the outlet. For all floors above the first the supply of fresh air passes upward from the first floor outlets and is drawn back for recirculation through the inlets to the fresh air shaft.

In order to give comfort in the boiler and engine rooms a special fan with 36-in. inlet and 3-ft. wheel is installed which takes air direct from the fresh air shaft and discharges by means of a duct with Y outlets into the engine room and also into the boiler room in front of the boilers. It is driven through Morse Silent chain by a 2-hp. motor.

The main ventilation and indirect heating apparatus is installed in the basement adjoining the boiler room and consists of two separate and independent sections. The air is drawn first to tempering coils and from these passes through an air washer, then to the heating coils and on into the air ducts. The tempering coils consist of 2272 sq. ft. of Vento cast iron radiation of American Radiator Co., arranged in 2 banks and 3 sections deep. These are supplied with steam from a header from which lead 2 4½-in. pipes with a valve in each pipe in addition to the control valve for each section.

The air washer is of the Acme type supplied by Thomas & Smith, of Chicago, and consists of vertical baffles with a hook-shaped front edge, in front of which are the water sprays supplied from a tank by a motor-driven centrifugal circulating pump and formed by means of spoon nozzles which give a double curtain. The air is cleansed and takes up a certain amount of moisture, all surplus being taken out by means of the baffle plates.

Air then passes on to the fans and is forced by these through the heating coils and into the ducts. The fans have 160-in. housings with open fronts and three-quarters housing. They have wheels 66 in. in diameter by 8 ft. wide and run at 163 r. p. m., giving a capacity of 35,200 cu. ft. of air each per minute. The 2 fans are mounted to drive from a single shaft connected by couplings to a 10 by 12-in. center crank horizontal engine of enclosed type mounted on a cast-

iron sub-base, the entire outfit being furnished by the American Blower Co. Steam for this engine reduced to 80 lb. is supplied through a 3-in. Kieley pressure reducing valve, and an Austin separator is used in the steam line, drained to the feed-water heater by a No. 1 Kieley trap.

Exhaust from the engine is carried to the boiler room and enters the auxiliary exhaust header which goes to the oil separator.

Both fans discharge into the same chamber in which are placed the heating coils. These coils consist of 3040 sq. ft. of Vento cast-iron radiation arranged in 2 banks and 4 sections deep. This heater is supplied with steam from 2 5-in. pipes with control valve on each in addition to the control valve for each section and the condensation is carried away through 3-in. iron ribs set 30 in. apart and riveted to the bottom of the duct.

Ventilating System

THE vertical flues leading to the first floor, which are 22 by 14 and 26 by 14 in., are of No. 24 sheet, and in all curved ducts the curves are made with the inside radius at least equal to the diameter of the pipe. All tapers are reduced gradually with laps laid in the direction of the air flow and rivets are spaced 2½ in. centers.

In the basement a flat damper is provided at each outlet, while for the first floor outlets the damper is placed at the base of the vertical flue, with deflector plates just below the curve to the outlet. This puts the control of all ventilation in the basement, convenient for operation by the engineer.

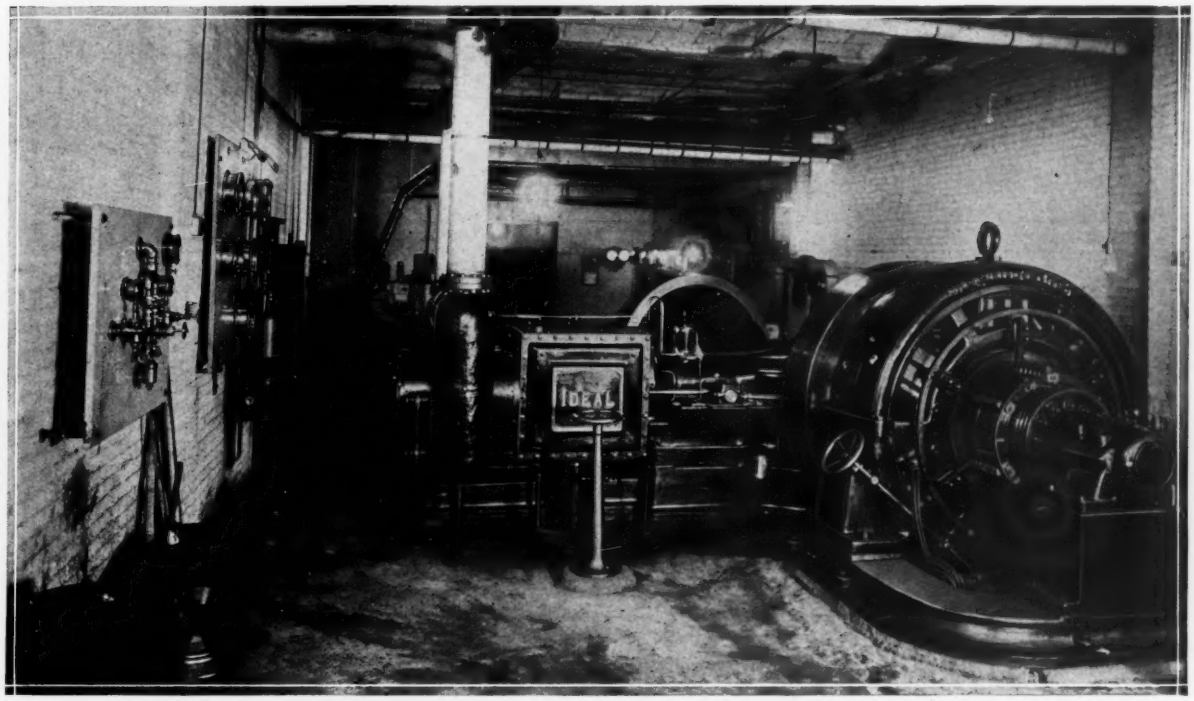


FIG. 4. ENGINE ROOM FROM FAR END SHOWING GAGE BOARD, PAUL SYSTEM AND AIR COMPRESSOR

returns to the feed-water heater. The free area through the coils is 75 sq. ft. Bypass dampers are provided under both tempering and heating groups so that in summer the air may be delivered direct to the flues without passing through the heaters.

The air washer has a capacity of 75,000 cu. ft. per minute at a velocity of 400 ft., water used in the water curtain being drained to a storage and settling chamber at the bottom and strained as it comes from this chamber to the centrifugal pump by a strainer with area 3 times that of the 3-in. suction pipe. The supply pipe to the curtain header is 2 in. in diameter. For flushing the storage chamber, a 3-in. pipe is provided connecting to the sewer. An automatic make-up supply is used for keeping the water level constant in the chamber.

Housings for the fans are made of No. 16 galvanized iron and the ducts, which are rectangular and carried along the basement ceiling, are of a thickness not less than 24 gage, and all over 24 in. wide are 20 gage, all over 30 in. wide being braced by angle

For the recirculation system a deflecting plate to throw the fresh air downward is provided at the fresh air inlet in the air shaft, and the registers for recirculating are provided with louvres, 2 registers being used on each floor, each one 54 by 36 in.

Ventilation of toilets and kitchen is by means of exhaust fans located in penthouses on the roof of the building. The toilet fan has a 3-ft. wheel 1 ft. 6 in. wide, running at 433 r.p.m., and is driven by a 2-hp. motor. The kitchen fan has a 3½-ft. wheel, 1 ft. 9 in. wide, running at 334 r.p.m. A separate fan is provided for ventilating the 3rd floor dining room. All fans are connected to the ducts by 3-ply canvas section, shellaced, and the motors are mounted on a 4 by 4 in. timber frame with 1-in. rubber cushion beneath in order to prevent all vibration.

Above the exhaust fan rooms on the roof are placed Burt ventilators, a 24-in. for the room in which the toilet fans are contained and a 30-in. for the room containing the kitchen and dining room fans.

Direct Radiation

AUXILIARY heating by means of direct radiation is provided on all floors, connections to the radiators being on the one pipe Paul vacuum system. Three styles of connection are used, one for wall radiators attached to the ceiling, such as are used for basement supplementary heating; a second for the first floor where the pipe comes up to the radiator through the floor, the mains being run on the ceiling of the basement below; the third, where the radiator is connected direct from the riser, as is the case on other floors. Radiators are placed against the wall wherever possible, with a few about stairways and wells where there is likelihood of cold air circulation. Direct radiation is also provided around the entrances of the first floor.

side of the reducing valve and a globe valve in the bypass.

From the low-pressure header a 7-in. main runs to the radiator supply system, a 10-in. main to the indirect heating coils in the fan room, an 8-in. main to the radiator system and a 6-in. heating main to the radiator system.

For supplying the radiators on the first floor 1½-in. risers are used and for radiators on the 2nd, 3rd and 4th floors 2½ and 3-in. risers, connections being made as needed. All radiators are supplied with packless valves and the heating throughout is equipped with Paul vacuum system.

Exhaust from all pumps and auxiliaries goes first to the oil separator and then through the 12-in. connection to the feed-water heater. Drips from the heat-

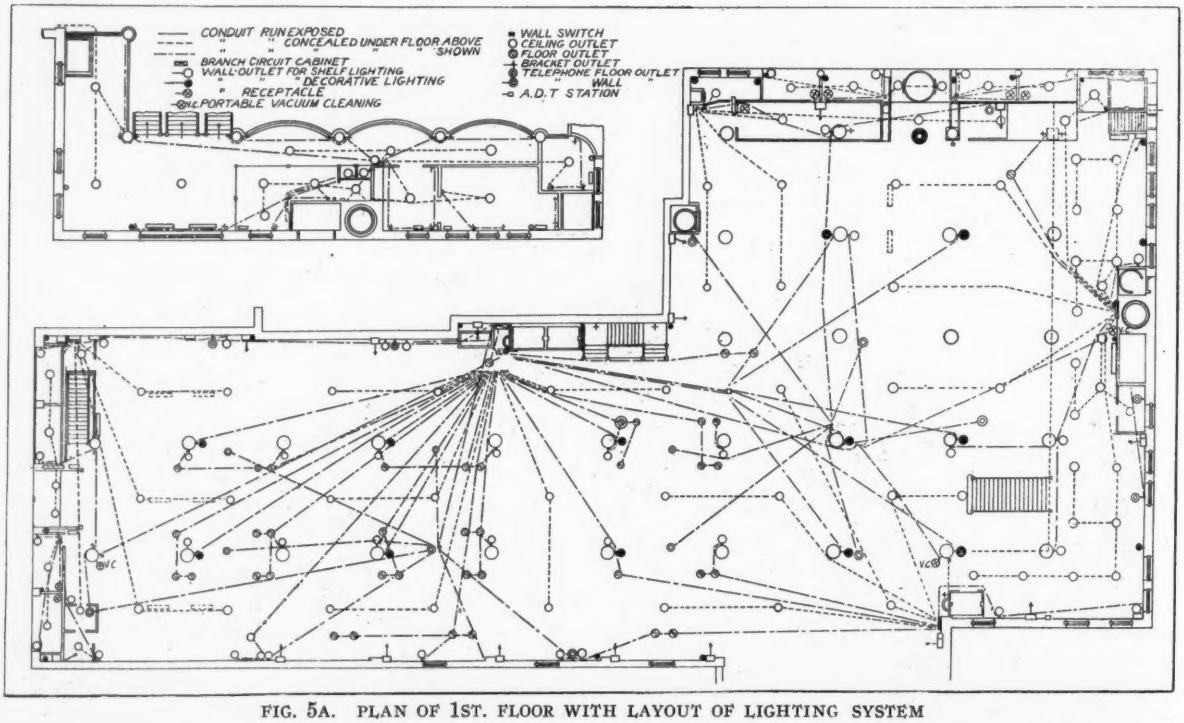


FIG. 5A. PLAN OF 1ST. FLOOR WITH LAYOUT OF LIGHTING SYSTEM

Exhaust steam is used so far as available and beyond this amount live steam is taken through a reducing valve to the low pressure header, from which distribution is made to both fan coils and direct radiators.

The method of steam supply for the direct radiation and fan heaters is best shown on the details of boiler room arrangement. Exhaust from the engines passes first to a 60 by 71-in. expansion tank type oil separator, then by a long radius bend to a Webster Star Vacuum heater with bypass connection taken to the heating system. The exhaust main from engines and to the heating system is 12-in. pipe carried through to a 12-in. low-pressure header with back pressure valve to an atmospheric exhaust running to the roof.

Into this low-pressure header steam is taken from the live steam header through a 6-in. pipe, then a 6 by 12 in. Kieley reducing valve and a 12-in. long radius elbow. A 5-in. bypass is provided around the reducing valve for emergency.

Control of the passage of live steam to the low-pressure header is by means of 2 gate valves on either

ing system and from the live steam system are taken to the return header and then through a 3-in. connection to the top of the heater.

Elevators

ELEVATORS used in the building are electrically driven. There are 3 passenger elevators each with a capacity of 3000 lb., with a speed upward of 200 ft. a minute; and a freight elevator with a 3000-lb. load capacity at 150 ft. a minute. The elevators are of the drum winding type with screw gear drive, operating on direct current at 220 volts, the motor direct connected to the screw shaft. Motors are compound wound to run on the shunt winding only, at full speed, have ring oiling bearings and carbon brushes.

All elevators are of the full magnet control type of the Otis make and are equipped with overload and no voltage release circuit breakers. Passenger elevators are of the tandem duplex worm gear type, the freight elevator having single worm and gear. All have steel guides and steel cages.

One of the special features of the store is an escalator or moving stairway, also of Otis make, running

between the first and second floors and driven by special motor located in the basement.

Special attention was given to the matter of adjustments for rather slow acceleration in starting so as to reduce the starting current and avoid flickering of the lights when the elevators start and stop.

Independent power feeders were run direct from the main switchboard in the engine room to the elevator controllers. Passenger elevator No. 3 is supplied by an independent feeder of 2 No. 0 wires in 2-in. conduit, passenger elevators Nos. 1 and 2 are supplied by one feeder of 2 250,000 circular mil cables in 2½-in. conduit and the escalator motor has an independent feeder of 2 No. 3 wires in a 1¼-in. conduit.

Lighting System

THIS is as complete as the heating and ventilating system. It is divided into 2 entirely separate parts, one the regular main store, show window and show case lighting and the second constituting a special decoration lighting system for holiday displays. The latter is largely provided with outlets on posts and in the floor from which short temporary lines may be run for special displays at different seasons.

General lighting is by means of ceiling chandeliers and bracket lights arranged with special reference to the location of counters. Feeders are carried to shafts at convenient points about the building. The main shaft is located near the elevators in the center of one side of the building, while a second shaft is located at the far end of the building, near the stairway and a 3rd near the fresh air shaft. A few circuits are carried up near the small elevator at the far side of the building and also in a flue at one corner of the ell.

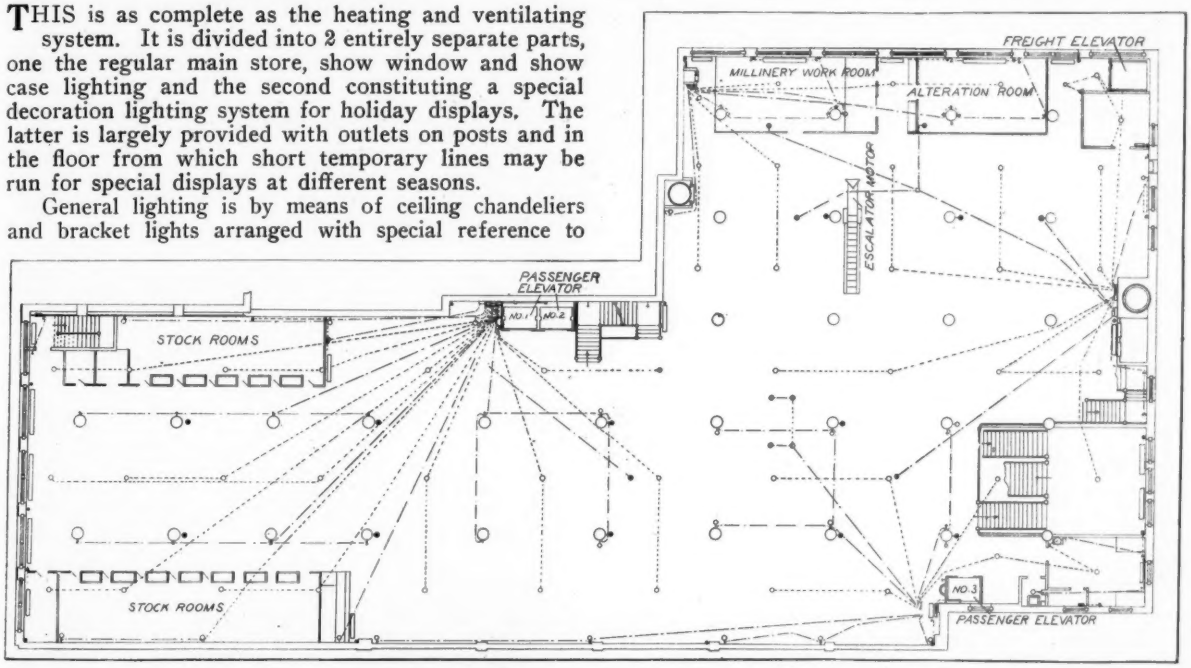


FIG. 5B. FLOOR PLAN OF 2ND. FLOOR WITH LAYOUT OF LIGHTING SYSTEM

As an example of a carefully laid out system and of completeness with which the entire matter has been gone over, the drawings for the wiring and outlets of most of the building are reproduced herewith, the table of symbols giving the key to the arrangement of lights, outlets and circuits. On the first floor special provision is made for the use of a portable vacuum cleaning apparatus at several convenient points.

Loricated iron conduits are used and where concealed they are run in the grouting over the steel beams and tile floors. Ends are reamed and butted together in the couplings at the joints and special care has been taken at the bends not to crack or flat the conduit.

Control of the circuits is by means of push switches located on the cabinet boxes, these switches being placed at one side of the door so that the cabinet box door need not be opened to turn the lights on or off. These cabinets are made of steel with iron bracing at corners, are lined with asbestos and fitted with steel doors.

Lighting circuits are proportioned according to the load carried, the mains for special show lighting and for the show windows being run separate from the general lighting and with special outlets at all necessary points, located 8 ft. from the floor.

Switchboard Equipment

ALL lines are taken from the feeder panels, being carried out through a pull box located at the base of the board. This board consists of 7 panels, 3 for feeder connections, 1 a service panel for measuring the power supplied for different purposes, 1 a totalizing panel for connecting all generators to the common busbars, and 2 generator panels for the units at present installed. Space is provided for a 3rd unit. The feeder panels are 30 in. wide, the service panel 26 in., the totalizing panel 24 in., and the generator panels 24 and 32 in. All panels are 60 in. high, with a 24-in. base below.

These panels are of marble 1½ in. thick, mounted on an angle iron framework and throughout the switchboard provision is made for 1 sq. in. of cross section in busbars per 1000 amperes carried, and 1 sq. in. of surface contact at joints per 100 amperes carried. The equipment of these panels is as follows:

Feeder panels are, of course, provided with switches and with fuses on the rear of the board for each circuit. There is a 250-ampere double pole switch, 2 150-ampere double pole switches, 5 100-ampere double pole switches, 9 200-ampere 3-pole, and 12 100-ampere 3-pole. On the service panel there is a 1000-ampere 3-pole station switch and a 500-ampere 2-pole station switch, both with enclosed fuses and rear connections. Also there are 3 wattmeters, 2 for lighting and 1 for power.

The totalizing panel is equipped with a 600-ampere ammeter, a 500-ampere wattmeter for measurement

of power, and a 1200-ampere wattmeter, all meters having glass cases. The buses have been proportioned for carrying current for the 2 present units and also for a future 200-kw. unit.

On the panel for the 200-kw. generator there are 2 800-ampere double pole single throw switches, 2 800-ampere circuit breakers, 2 200-ampere double-pole single-throw switches, 2 200-ampere ammeters, a voltmeter receptacle and a rheostat mounting, the rheostat being chain-driven and located on the floor. The panel for the 100-kw. machine has a 2400-ampere circuit breaker arranged for overload and reverse current, 2 400 and 2 100-ampere double-pole single-throw switches, 2 600-ampere ammeters, a rheostat, and at the end are 2 300-volt voltmeters mounted on a swinging arm so that they may be seen from any point of the switchboard. The voltmeter receptacles and plug provide for throwing either voltmeter onto either generator or bus. A ground detector is also provided, mounted on the 100-kw. panel.

In the arrangement of the busbars 2 sets are provided, power being taken from the upper busbars and lighting from the lower. In this way either generator may be run on either kind of load, while the other

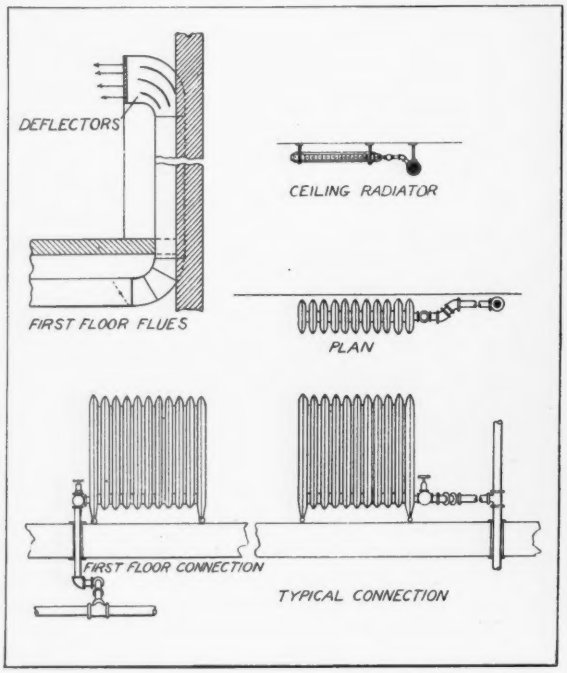


FIG. 6. DETAILS OF RADIATOR CONNECTION, AND DUCT OUTLETS

generator is carrying the other load, or the 2 sets of buses may be tied together if desired and both power and lighting taken from a single machine. As a matter of fact the buses are seldom divided, the generators running in multiple with the buses tied together and supplying both lights and power, including elevators. Under these conditions the lights are very steady, no objectionable flickering being noticed.

Balancing Coils

THE generator connection has a special feature which explains the use of some of the switches. A diagram of connection is shown, the 4 slip rings indicated at the right hand of the armature being for the balancing coils. As one of the series coils is placed in the negative and one in the positive lead, to get compounding on both sides of the system, it is necessary to use 2 equalizer bars, one for the positive side of the machines and one for the negative side. Balancing coils are necessary because the generators are for 230 volts at the brushes, which is used on the power circuits, while the lights are connected on the 3-wire system 110 and 220 volts.

The balancing coils serve to take care of any unbalancing of load and have sufficient capacity to handle 25 per cent unbalancing and 2 per cent variation of voltage.

As indicated in the diagram, the ammeters are connected across shunts and the neutral wire is connected to the centers of the balancing coils. These coils are tapped in by means of slip rings on the armature

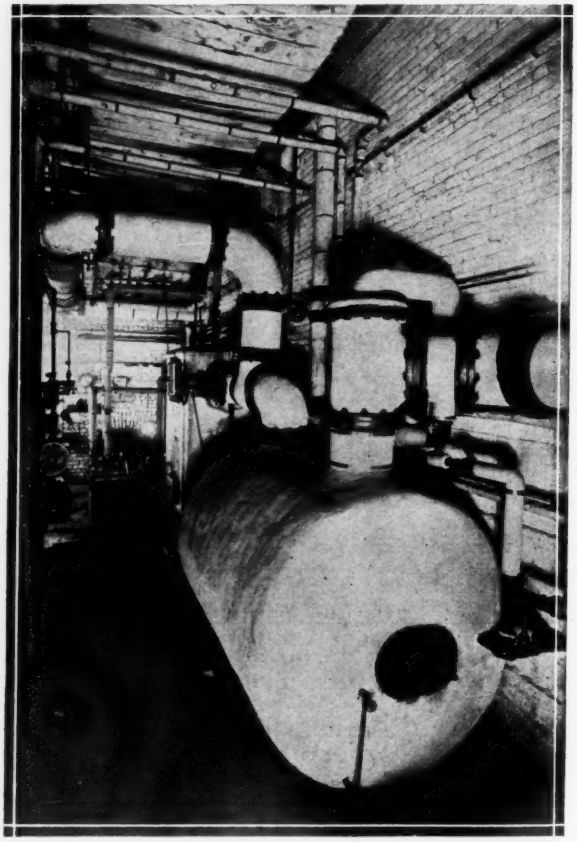


FIG. 7. HEATER, OIL SEPARATOR AND PUMPS

shaft, so as to span 220 volts alternating. The neutral wire is then connected to the middle of the balancer coil, giving a path for return current which may be brought in by the neutral at 110 volts from either side.

Generators

THE generators, furnished by the Westinghouse Electric Co., are of the engine type, 100 and 200 kw. capacity at 250 volts, with normal load rating of 400 and 800 amperes respectively. They will operate at from 0 to 150 per cent overload without shifting the brushes and with no sparking. The shunts are adjusted for 230 volts and for parallel operation with load divided in proportion to the capacity of the machines. Current from the generators to the switchboard is carried by double-braided, rubber-

core, stranded conductors carried in iron conduits beneath the floor.

The winding of the armatures is of the drum type, mounted in open slots and the efficiency guarantee for the 100-kw. machine was 91 per cent at ½ load, 91.5 per cent at ¾ load, 91.2 per cent at full load, and 90 per cent at 1¼ load. For the 200-kw. machine the guarantee was, ½ load 91.5 per cent, ¾ load 92.5 per cent, full load 93 per cent, and at 1¼ load 92.5 per cent.

Engines

THE generators are direct connected to Ideal engines, built by A. L. Ide & Sons, of Springfield, Ill., and the specifications called for the following conditions, which the engines have fulfilled: They are side crank type, tandem compound with extension bases for mounting generators and with outboard bearings. They were run for 8-hr. full load test to determine steam consumption, regulation, etc. The 100-kw. machine runs at 260 revolutions per minute and has cylinders 13 and 20 by 14 in. The 200-kw. runs at 200 r.p.m. with cylinders 18 and 27 by 18 in. They run with 125 lb. steam pressure and 2 lb. back pressure, and regulation 1½ per cent either way from normal, and return to normal within 4 revolutions after a variation of load from 0 to ¾ or from ¼ to 1¼. The splash oiling system is used with Russia iron oil guards, and ring oilers for the outboard bearings; Sherwood cylinder oilers are supplied with one feed to the steam chest and one to the throttle. To reclaim oil that has been used in the bearings an American oil filter, furnished by the Burt Mfg. Co., is provided.

The smaller engine has 5-in. steam pipe and 6-in. exhaust with 68-in. governor wheel, 14½ in. face, weighing 20,000 lb. The larger engine has 7-in. steam pipe, 8-in. exhaust and governor wheel 78 in. in diameter by 16 in. face and weighing 37,000 lb. Each engine is mounted on cast-iron sub-base extended above

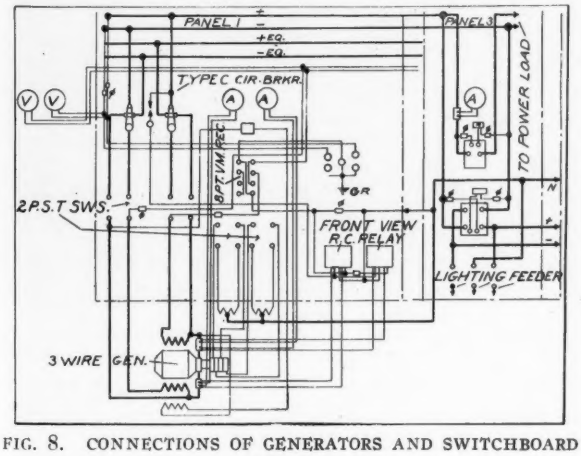


FIG. 8. CONNECTIONS OF GENERATORS AND SWITCHBOARD PANELS

the floor and shaft extended on the governor side to pass through the field ring of the generator to the outboard bearing.

For the smaller engine the shaft diameter is 7 in. in the bearings, 9 in. in the armature and the length in the bearings is 18 in. For the outboard bearing the diameter of the shaft is 6 in., length 14 in., the crankpin is 5 in. in diameter by 4 in. long, crosshead pin 3⅜ in. in diameter by 2⅝ in. long, and the slide has an area of 87 sq. in.

For the larger engine the shaft is 8 in. diam. in the main bearing, 10 in. through the armature and the main bearing has a length of 18 in.; the diameter of the outboard bearing is 7 in.; crankpin is 6 in. diam. by 5 in. long, and the crosshead pin 4¾ in. in diameter by 4.5 in. long. The area of the slide is 122 sq. in.

Operating between the pressures as previously stated, the guaranteed steam consumption for the larger unit is, at ¼ load 46¾ lb., at ½ load 33½ lb., at ¾ load 28½ lb., at full rated load, 26½, and at

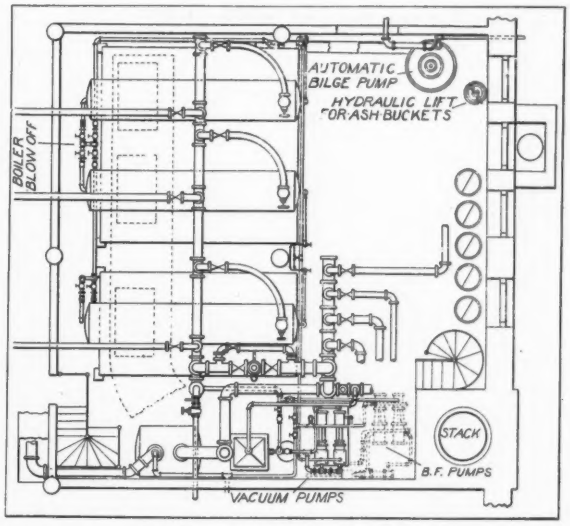


FIG. 9. PLAN OF BOILER ROOM

25 per cent overload 26½ lb. of steam per hour per horsepower. Each engine is equipped with an Ideal angle type receiver separator, and an unusual requirement for these engines was that a Crosby indicator should be furnished with outside spring reducing wheel and detent motion, and with nickel plated indicator connection pipe and cock.

Boiler Plant

BESIDES supplying steam for the engines the boiler plant furnishes a steam supply to the kitchen for cooking and heating. A 1¼-in. live steam line supplies steam through a 1½-in. reducing valve which reduces from 130 to 35 lb., and the condensation from the kitchen kettles is returned through a V. D. Anderson Co. float trap and a ¾-in. return pipe to the return header. A 1-in. pipe runs to the 3rd floor kitchen, and the returns from this also come through an Anderson trap and ¾-in. pipe to the header.

A hot water tank is connected by means of a 1¼-in. high pressure connection for heating the water for house service, and condensation from this service returns to the header, as in other cases.

To furnish steam for all this varied service a boiler plant is installed, consisting of 3 water-tube horizontal boilers made by the Murray Iron Works, Burlington, Iowa. Each is designed with 2000 sq. ft. of heating surface to evaporate 6578 lb. of water an hour at a pressure of 150 to 160 lb. and with feed water at 212 deg., and each is capable of carrying a 40 per cent overload continuously without injury.

Specifications called for a steel of 55,000 to 65,000 lb. per square inch tensile strength and elastic limit ½ the breaking strength, with ultimate elongation of 25 per cent and reduction of area at fracture of 50 per cent.

These boilers are arranged with Murphy inclined grate stokers, having a tile arch roof, and with hanging baffle plates along the lower row of tubes. A series of baffles are also installed along the top row of tubes, so that the gases pass first from the fire box underneath the tubes to the rear end of the boiler, then up through the tubes and horizontally to the front end of the boiler and from there along the under side of the steam drum and to the breeching. This breeching is composed of No. 10 sheet steel braced with angle irons and having a cleaning door. It is covered with 85 per cent magnesia covering 2 in. thick and leads by a 90-deg. gradual turn shown in the basement plan of the building to the stack. The main damper, situated in the breeching near the stack, is controlled by a Locke regulator.

slack coal, the standard form of stoker being used with flush front matching the boiler front.

Piping and Auxiliaries

IN laying out the piping for the boiler room, particular attention was paid to getting durable construction and a convenient arrangement. From each boiler an angle valve and long bend connection of 6-in. pipe leads to the 10-in. high-pressure header, which is pitched toward the delivery end. Connections are made to this header in the top, both for the supply of steam from the boilers and the supply of steam to the engines, with a gate valve at the upper end of the long radius connecting L in each case.

The specifications required that standard pipe be used and extra heavy fittings, that the bends be made

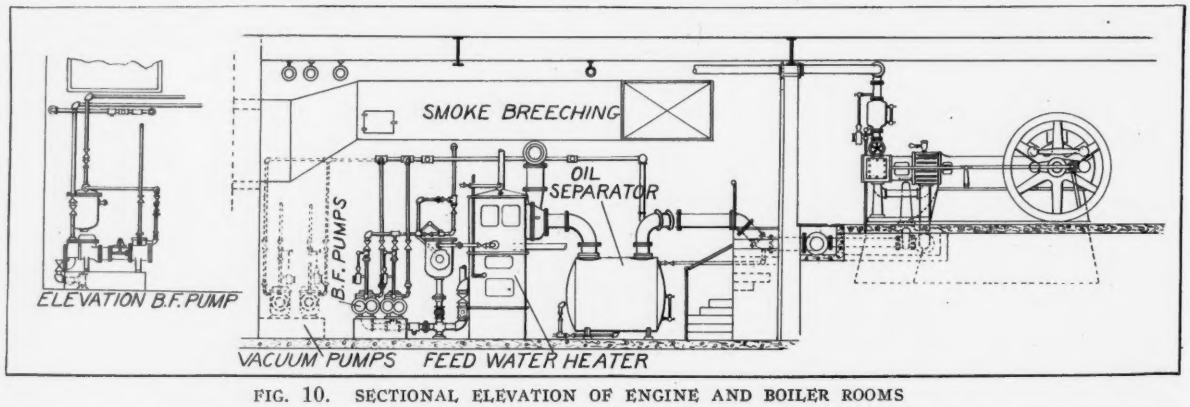


FIG. 10. SECTIONAL ELEVATION OF ENGINE AND BOILER ROOMS

Boilers are arranged with surface and mud drum blowoff valves leading to a blowoff header which discharges into the catch basin. To control the blowoff 2-in. Crane blowoff valves are provided, backed up by Homestead plug cocks, the blowoff pipe being 2½ in. in diameter throughout.

Boilers are fed from the front, a 3-in. pipe being carried to the first boiler and there reduced to a 2-inch. From this feed line a drop leg is taken with a gate valve near the bottom and an upward turn is then taken to carry the 2-in. feed into the lower part of the steam drum, a globe valve being used to regulate the flow to each boiler. A 1-in. cold water line is carried along in front of the boilers and tapped into the feed for emergency use. In front of the boilers is also the exhaust steam line from the stoker engine, which discharges underneath the grates into the ashpits.

Each boiler is provided with a No. 5 Reliance gage column fitted with 3 Lunkenheimer ¾-in. try cocks and having 1¼-in. connection to steam and water spaces and a ¾-in. blow-down valve leading to the ashpit. Ashcroft gages and American safety valves are used, the safety valves having nickel seats. The boilers are carried on links supported by I beam framework and have the steam drums covered with an inch of 85 per cent magnesia boiler covering and the space above the boilers then filled with brick and cement mortar, leaving a small air space above the magensia covering.

The specifications provided for the furnishing of these boilers with a turbo-driven tube cleaner and also that each boiler should be tested by the Hartford Boiler Inspection & Insurance Co. at the factory to 250 lb. hydraulic pressure. The stokers were equipped to burn Illinois or Pennsylvania bituminous

hot and that the flanges on the high-pressure circuit be provided with corrugated copper gaskets and on the low-pressure system with Rainbow rubber gaskets. All steam pipe and returns from the heating system are installed with a pitch of ½ in. in 10 ft. and drop legs are used to give a water seal where the return lines unite. Eccentric reducing fittings are used at all points where reduction of size is necessary.

Feed lines are provided with extra heavy brass gate valves, extra heavy brass globe valves and extra heavy brass swing check valves, also extra heavy long-radius fittings of malleable iron are used for the feed and blowoff lines. The blowoff line and the returns are laid in trenches in the boiler room floor with heavy cast-iron covers.

Feed for the boilers is supplied by 2 Blake boiler feed pumps connected in parallel to draw water from the Webster heater and force it to the boilers, a Mueller boiler feed pump governor controlling the speed of these pumps according to the level of the water in the heater. The suction of the pumps may also be taken direct from the return header by means of a 4-in. bypass which leads direct to the pump suction line.

The pumps are 7½ and 5 by 6 in. with outside packed plungers, brass lined water cylinders and Tobin bronze rods. In order to shut down these pumps, if the feed line pressure gets too high, a 1½-in. Foster pressure regulator is installed in the steam line leading from the boiler to the pumps and is set at 250 lb. pressure. High pressure lines, exhaust header and exhaust line elbows all drain to the heater which has a 2½-in. vent leading into the 12-in. atmospheric exhaust line.

All valves on pipe over 3 in. are of the outside

rising spindle type with bronze stems, valve seats and disks. For the high-pressure lines the valves are extra heavy and for the low-pressure standard. Below 3-in. the valves have brass bodies and for 2½-in. and over in the steam line they are gate valves, under 2½-in. globe valves. In the water lines 1½-in. valves and over are gate valves except in the boiler feed line. All globe valves are of the regrinding type. Pipes are covered throughout the plant with 85 per cent magnesia covering furnished by the Keasby & Mattison Co.

The oil separator and expansion tank is of the expansion tank type, 5 ft. in diameter, 6 ft. 6 in. long, with special flange for 12-in. pipe connections and provided with drains and blowoff connections. For draining the catch basin a Yeoman's automatic electric bilge pump is used, controlled directly by a float located in the catch basin and operating the controller which is mounted on the cover of the basin. This pump has a capacity of 100 gal. per minute under 25 ft. head.

Coal is stored in a space at one side of the boiler room under the sidewalk, this pocket having a capacity of 2 carloads. Coal is brought from the pocket to the boiler room on side opening cars and shoveled into the stoker hoppers, Hocking Valley screenings being used.

For the removal of ash a hoist run by hydraulic pressure is installed to lift the buckets to the street level. The buckets are 30 by 36 in. and the lift necessary 29 ft., which is reduced by a pulley arrangement to 14½ ft. travel for the hoist cylinder. The sheaves used are roller bearing carrying ½-in. cable with hook and being arranged with casing and crane so that the buckets can be swung over a wagon in the alley.

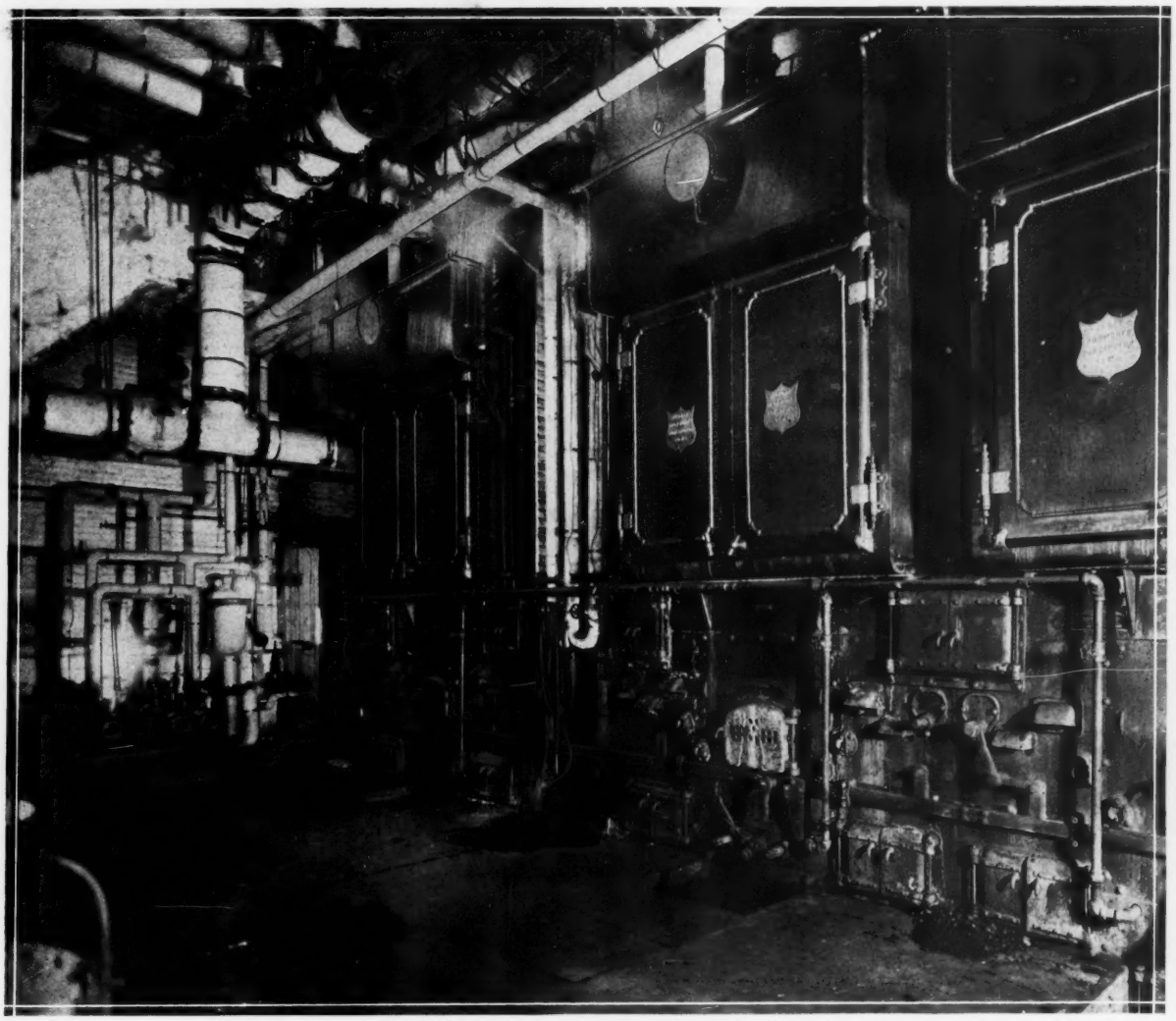


FIG. 11. BOILERS, STOKERS AND PUMPS

Fire protection is secured by means of a sprinkler system covering the entire store and to keep up pressure on this system a Westinghouse compressor of the air brake type is installed in the engine room.

To keep in evidence exactly what is happening in various parts of the plant an Ashcroft gage board is installed, carrying a boiler gage which registers 142 lb. and receiver gage showing 19 lb., a vacuum recording gage and a boiler pressure recording gage.

The planning of the entire mechanical equipment of the store and the installation of all machinery has been in charge of Chas. L. Pillsbury, Consulting Engineer, of Minneapolis.

PRACTICAL PIPE FITTING

By Walter C. Edge

AMONG the many trades with which the engineer of today must become familiar, pipe fitting predominates. He must not only be able to make piping repairs, but must be able to lay out and install new work as well.

Heating Coils

IN running the steam pipe to a coil as shown in Fig. 1, an accurate job can be obtained by screwing a piece of pipe into the coil fitting; then measure from the coupling of the last length to the center of the pipe. If this is 1-in. pipe this measurement will be the exact length to cut the pipe, as the pipe will screw into the coupling ¾ in., which will be necessary to add to the measurement and it will be ¾ in. from the end of the pipe to the center of the ell, which would have to be deducted, bringing you back to the original measurement.

If it should be ½ or ¾-in. pipe, the circumstances will be the same, as each of these sizes will make

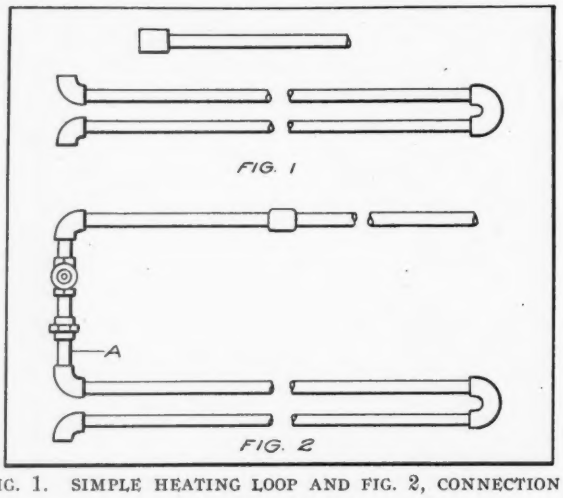


FIG. 1. SIMPLE HEATING LOOP AND FIG. 2, CONNECTION TO SUPPLY LINE

into the coupling a distance equal to that lost on the ell end. For 1¼, 1½ and 2-in. pipe, ¼, ½ and ¾ in. respectively, should be deducted from the original measurement.

After screwing this piece into the coupling, cut the drop piece so as to place the valve at the proper height and screw this into the ell, then procure a nipple and union and screw them into the valve; then you have the piping as shown in Fig. 2, omitting piece A. Now measure the distance A and add 1 in. for ½-in. pipe, as it will make into the coil fitting ½ in. and into the union ½ in. If ¾, 1, 1¼ or 1½ in. pipe is used, 1½ in. must be added, and for 2-in. pipe add 2 in. When you have the proper size nipple, take the union apart and make the lower half, along with the nipple just secured into the coil fitting, tighten on the union nut and the steam line is all ready.

In running all steam lines care should be taken to give them enough slope to drain properly, avoiding all pockets, etc. Crosses should be avoided in running steam lines, and all piping should be laid out so as to avoid sharp bends wherever possible. Sharp bends are especially bad in exhaust lines, where it is necessary for the steam to get away quickly, in order to avoid back pressure.

Fig. 3 shows one way of connecting exhaust pipe into the main pipe by the use of tees, but Fig. 4 shows a better way by using Y's and 45-deg. ells.

In fitting up a tank where it is desirable to have both air and steam blow into it, a good connection is shown in Fig. 5. Instead of running 2 pipes into the tank, run the air line only, and connect the steam line into it below the cock.

Figures 6, 7 and 8 show 3 different coils used extensively for heating offices, workrooms, factories, etc.

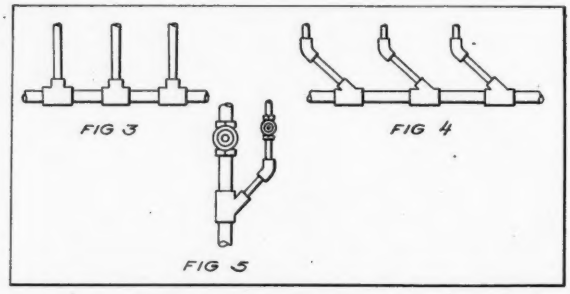
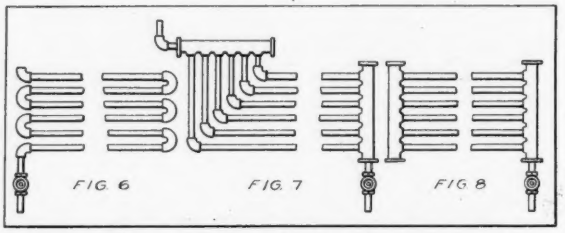


FIG. 3. ORDINARY CONNECTION OF EXHAUST BRANCHES TO MAIN AND FIG. 4, A BETTER METHOD
FIG. 5. CONNECTION FOR COMBINED STEAM AND AIR SUPPLY

Of these Fig. 6 is the easiest to make, being nothing more than the pipe cut to the proper length and made to fit into return bends. Figure 7 requires more material and considerable more work to make, but it is a much neater and better looking coil. Procure 2 6-



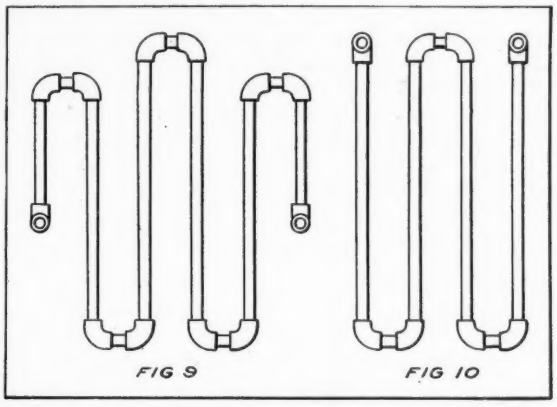
FIGS. 6, 7, 8. FORMS OF PIPE COILS FOR HEATING

pipe manifolds, one tapped with right-hand threads and the other with left-hand; measure the distance from the center of one outlet to the center of the next, then cut 6 nipples making each one the distance between outlet centers longer than the preceding one. Take care to have all the threads the same length; screw an ell on each nipple and make them all up in the right-hand manifold in the order shown in Fig. 7.

Cut the pipe lengths in the same fashion as the short nipples, making them any desired length, with a right-hand thread on one end and a left-hand thread on the other. Screw the left-hand end of the pipe into the left-hand manifold, then take it out and try it in the ell. If the ends make up the same distance in each fitting, start the pipe into the ell and manifold at the same time, but if the right-hand thread should make up 2 threads more than the left in the

trial, the pipe should be entered into the ell 2 threads before starting it into the manifold.

After starting the first, the second should be started, then the third, etc., until all are started by hand only, then they can be made up with the wrench gradually, alternating from one to another until all are tight. A much better job can be made on work of this kind by the use of 2 wrenches, one applied at each end of the pipe.

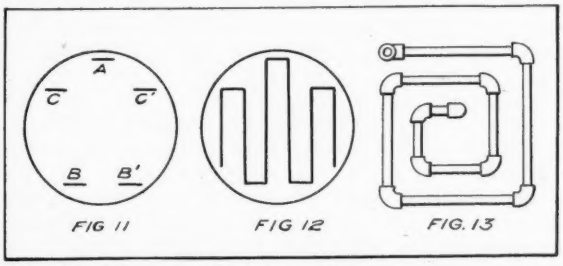


FIGS. 9, 10. HEATING COILS FOR ROUND AND RECTANGULAR TANKS

Figure 8 is made in the same way as Fig. 7, with a right and left-hand manifold, but it is a much more difficult coil to make, owing to the fact that there is no spring in it. If one pipe is cut ¼ in. longer than the next, or one thread is a little longer than it should be, it will not make up right.

Tank Coils

IN addition to this class of steam coils, another class exists, namely, tank coils, used for heating various liquids found necessary to heat in many different plants. Figures 9 and 10 show the same style coil, one made for a round tank, and the other for a rectangular or a square tank. These coils are generally made from 2-in. pipe and take very little time to make. If the coil is for a round tank draw a circle

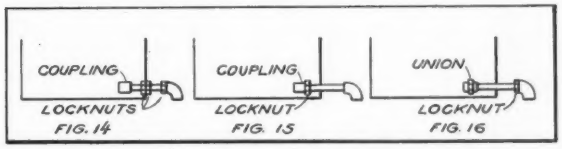


FIGS. 11, 12. LAYING OUT A COIL FOR A ROUND TANK
FIG. 13. TANK COIL FOR CENTER DISCHARGE

on the floor equal in diameter to the tank by taking a piece of twine the radius of the tank in length, fastening one end to the floor and marking off the circle with pencil or chalk at the other end; then draw a straight line through the center of the circle as a center line.

After deciding what distance you wish your pipe to be from center to center draw a line this length at one end of the dividing line, as shown in Fig. 11, line A keeping at least 3 in. from the circumference of the circle. If the desired distance is 12 in. your next 2 lines will be 12 in. apart, 6 in. each side of the center line as shown by lines B and B′. The next 2 will be each side of the center shown by lines C and C′, etc., until the bottom of the tank is covered; then fill in the lines representing the lengths as shown in Fig. 12, and you have your coil laid out completely. Measure the length and subtract 3¼ in. for 2 2-in. ells.

Of course this can be drawn on paper if desired, by drawing the circle 0.1 size or any other size provided that it is drawn to scale. When you have the pipe cut and threaded, screw an ell on each end of one of the short pieces, and an ell on one end of all the other pieces. Always start making the coil from



FIGS. 14, 15, 16. METHOD OF FASTENING OUTLET PIPE TO TANK

the center and work toward each end, using the piece with 2 ells for your center piece. For a coil similar to that shown in Fig. 10 subtract 9 in. from the length of the tank and you have the length of the pipe needed. This coil is made up in the same manner as the other.

Figure 13 makes a good coil for a square or rectangular tank where the exhaust must come from the center of the tank.

The exhaust from all coils placed in tanks should be brought through the bottom or side of the tank and never run out the top, as it makes it impossible for the coil to drain with the exhaust running up.

Tank Connections

THERE are several different ways of bringing the exhaust through the bottom or side of the tank. It can be accomplished by making a clearance hole in the tank and running the exhaust through with a long threaded nipple, and putting locknuts on the nipple inside and outside of the tank and also against the ell, as shown in Fig. 14. Although this is the quickest way it is the poorest way to come through the tank. Figure 15 shows another way to make the connection. The long threaded nipple is screwed from the outside into a threaded hole making into the coupling, or other fitting on the inside, this makes up tight into the tank, and by the use of a locknut it is made tight in the coupling.

Still another method, which the writer considers the best connection, owing to every joint on the inside of the tank being absolutely tight without the aid of a locknut, is accomplished by screwing the long threaded nipple through the tank from the inside joining the end of the nipple with the exhaust by using a ground joint union and bringing a locknut up against the ell on the outside. This connection is shown in Fig. 16.

Joint Fillers

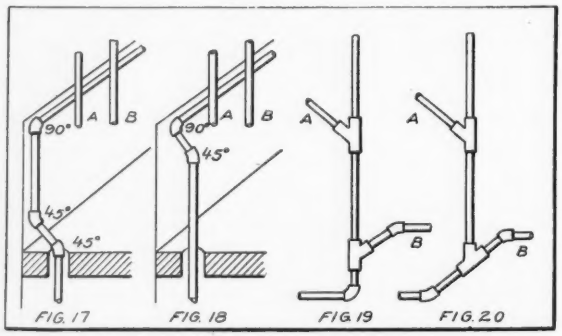
THE best and tightest pipe fitting is accomplished by the use of a filler on the threads. The writer considers graphite and cylinder oil the best for steam pipe, white lead for water pipe, and litharge and glycerin for ammonia pipe. This last filler sets so quickly that only enough for one joint should be mixed at a time, and when the joint is once made it

should not be disturbed as the filler is useless if broken when it has once set.

Saving Fittings and Friction

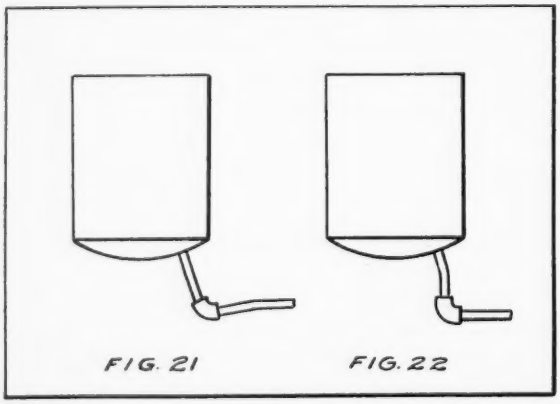
AN engineer who does not understand pipe fitting thoroughly, may cost his employer a considerable sum of money by waste of fittings in the construction of the various piping lines, not only from extra cost for installation, but from continual loss, due to extra friction in the piping.

Figures 17 and 18 demonstrate one case where a 45-deg. ell may be eliminated. The piping shown comes through the floor in the corner of the building 10 in. from the outer wall, owing to an 8-in. girder running around the building. This pipe must not be



FIGS. 17, 18. TWO WAYS OF OFFSETTING A VERTICAL RUN
FIGS. 19, 20. PIPING AN EXHAUST TO AVOID FRICTION

more than 3 in. from the wall on the second floor horizontal run, to enable it to pass upright pipes A and B. Figure 17 shows how it is done by the use of 2 45's and a 90-deg. ell, while Fig. 18 gives a method of accomplishing the same thing with the use of a 90-deg. ell and 1 45-deg. by making the 90-deg. bend, and at the same time pointing the ell 45 deg. Figures 19 and 20 show 2 methods of piping an exhaust return. In Fig. 19 the exhaust returning from B must make 2 45-deg. and a 90-deg. turn, while Fig.



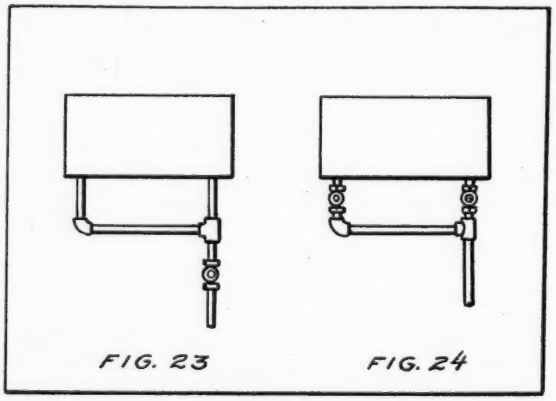
FIGS. 21, 22. GETTING THE BEND IN THE RIGHT PLACE

20 illustrates a method by which it may pass this sectional piping with 2 45-deg. turns; and the exhaust returning from A has a gradual bend in place of the sharp one shown in Fig. 19.

In running the exhaust from tanks you sometimes come across a pipe which is not exactly perpendicular owing to the hole being tapped crooked, or the tank having a dished bottom. To get over this difficulty some engineers bend the horizontal pipe as shown in Fig. 21. This method makes a pocket in the piping, not hard to see. The best method is to bend the upright as shown in Fig. 22 thus giving the pipe the proper slope.

A Wrong Drip

THE writer has come across jobs where economy was practiced so thoroughly as to do more harm than good. One job in particular was the drips from a pump, connected as shown in Fig. 23. Whether the pump was connected this way, because only one small valve was available, or whether through ignorance, I am not prepared to say, but the loss of steam was considerable owing to a constant back pressure on the piston and leak to exhaust. The proper way to con-



FIGS. 23, 24. A BAD DRIP ARRANGEMENT AND ITS CORRECTION

nect the pump would be as shown in Fig. 24, then when the drip valves were closed the steam could not work from one end of the cylinder to the other.

Valve Pointers

WHEN a globe valve is put in a steam line, it should be so placed as to shut off against the steam, or in other words, so the steam will come under the seat. When the valve is put in this way it may be packed very easily with the steam pressure back of it.

All valves before being put in a line of piping should be put in a vise, the bonnet screwed off, and a liberal supply of graphite and oil given the threads, so that the bonnet will come off when a new disk is needed.

All steam lines should have a drip pipe run from the lowest point in the line to a steam trap, so as to keep the pipe free from water, thus avoiding water hammer.

In joining a flange union the flanges must meet squarely, so that the bolts may easily slip through the holes. The writer has seen some joints where one half of a flange union was out of line so much with the other half that a bar must have been used to spring it enough to enter the bolts. Of course this flange always leaked.

Then the nuts must be drawn up gradually, alternating from one to another until a tight joint is made. Thin rubber will make the best joints, unless the surface is exceptionally rough, when heavy rubber should be used.

ONE LOOSE BEARING on a machine has a tendency to loosen others, causing knocks, loss of power and the crystallization of metal.—Popular Mechanics.

DETAILS OF POWER PLANT DESIGN

BLOWOFF, HOT WATER HEATERS, VENTILATION

By Charles L. Hubbard

BLOWOFF tank and connections are a simple matter but of considerable importance when the boilers are necessarily blown down into the sewer. This condition makes it necessary to cool the water to a certain point to avoid heating the tile pipes and causing leaks at the joints.

When the tank is to be sunk in the earth, it should always be of cast iron to resist corrosion; boiler plate may be used when the tank is to be supported above ground on brick piers or iron saddles. The size of the tank depends upon the maximum quantity of water to be blown down at one time; examination of a considerable number of cases where cylindrical tubular boilers were employed, showed the blowoff tank to have a volume about 1/24 that of the boilers it was desired to blowoff at one time. If standard or ready-made cast-iron tanks are to be used, 2 or more may be used in series to get the desired capacity. If a tank of boiler plate is installed, it may be designed especially for the case in hand. The inlet to the tank from the boilers should be in or near the top, and the outlet should be through a pipe entering the tank at about the same level, but extending downward on the inside to a point near the bottom.

With this arrangement, hot water from the boilers will enter at the top of the tank and cool water will be forced out from the lower part. The tank should be vented at the top, and the overflow or discharge should be vented at the highest point to prevent any siphon effect which would tend to empty the tank after a discharge flow was once established.

Hot Water Heater

ALTHOUGH not strictly a part of a power plant, the hot water heating and storage tank is usually designed and installed under the direction of the engineer.

For laundry and hotel plants where there might be damage from iron rust in the water, the tank is usually made of copper in the best class of work; but for ordinary lavatory purposes in an office building an iron tank with a copper or brass steam coil is more commonly employed.

Assuming the water to be heated from 50 deg. to 180 deg. or an average temperature of 115 deg. in passing through the tank, we may use the following values for gallons of water heated per square foot brass coil heating surface: For high-pressure steam at 60 to 70 lb. gage, 105 gal.; and for low pressure, 2 to 3 lb., 35 gal.

Both the inlet and outlet to coils of this kind should be attached to the same head of the tank, so that by reversing one head the coil can be drawn out of the shell without breaking connections inside the tank.

Sometimes regular feed-water heaters are used for this purpose. If these are rated on 1-3 sq. ft. of heating surface per horsepower, the required size can easily be determined by the method given above.

Heaters of this kind should always be provided with thermostats for maintaining a constant temperature of the water in the tank. These operate either by the expansion of a rod or the volatilization of a liquid when the water reaches a certain temperature, the effect of which is to shut off the steam supply to the coil. Regulators operated in this way generally have a certain range of temperature for which they can be set. There are cheaper forms which simply act when the water reaches a temperature slightly below that of the boiling point, and therefore act as a sort of safety valve.

Such heaters are generally designed so they may employ exhaust steam, on account of utilizing it in summer when it would otherwise be wasted. A cross-connection by means of a reducing valve should be made with the high-pressure system for use in cases of emergency.

Ventilation of Boiler and Engine Rooms

THIS is sometimes accomplished by forcing in cool air, sometimes by exhausting the hot air and allowing the fresh air to find its way in by open windows or specially provided air-shafts. In many plants, simply a vent flue is furnished which allows a portion of the heated air to flow off by gravity.

The best arrangement is to provide means for blowing in a generous quantity of fresh cool air, delivering it at the hottest places where the attendants have to work, as along the boiler fronts and around the engines. The air currents should be broken up by means of deflectors or diffusers so as not to produce cold drafts on those near by.

Removal of the air from these rooms may take place in 2 ways; first, a considerable quantity is required for the combustion of fuel, approximately 300 cu. ft. for each pound of coal burned. The surplus may be carried off by means of a special flue reaching to the top of the building. As already stated, a good arrangement for this purpose is to use a steel boiler stack carried up inside a brick shaft and use the space around the stack for ventilating the boiler and engine rooms.

Rate of change of air will depend somewhat upon the cubic space of the rooms as compared with the amount of apparatus which they contain and the quantity of heat given off. For the average crowded conditions found in city basements, the entire air contents should be changed from 6 to 10 times an hour, preferably at the latter rate. The table gives the approximate size and speed of fans and motors.

Fan Capacities (Blower Type) and Motor Power Required

Diameter of fan, in feet.	Revolutions per minute.	Cubic feet of air moved per min.	Horse power of motor.
3	400	5,600	3
4	350	11,200	6
5	275	17,000	8
6	225	24,000	10
7	200	32,000	15

Sometimes the hot air is exhausted from the boiler and engine rooms, and cool air allowed to flow in by gravity through an air shaft. When forced draft with a closed ashpit is employed this may give satisfactory results, but with natural draft it is better to have the boiler room under a slight pressure rather than a vacuum, and again, when the cool air is introduced under pressure a better distribution is obtained, as it may thus be delivered at the points where it is most needed.

THE HOLLY STEAM LOOP

By J. C. Hawkins

HAVING read in the past issues of Practical Engineer several articles concerning the trouble had with steam traps and pumps when used for taking care of the condensation from steam lines and also some brief mention of the use of the steam loop, the writer gives herewith a diagram of the piping of a plant in which the condensation from all of the high pressure steam lines is taken care of and returned direct to the boilers without the use of either a trap or pump, but solely by means of the steam loop and Holly gravity return system. The plant is about 800 hp. and consists of 4 boilers, 5 engines and 6 pumps of various sizes. The practical operation of this system is, in the writer's estimation, as near perfect as it is possible to get at the present time, and the system has been in constant operation for 2 yr. with only 1 or 2 shutdowns to repair a split coupling and a defective valve which could not be called trouble as compared with the average steam trap or pump.

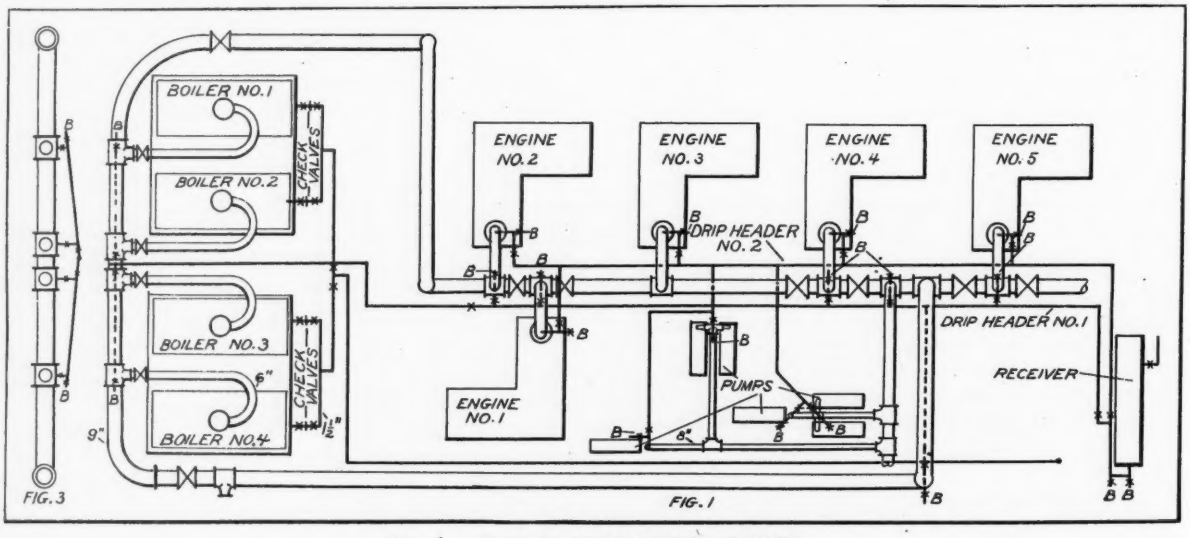


FIG. 1. PLAN OF PIPING HOLLY SYSTEM
FIG. 3. DRIP HEADER AND MAIN STEAM HEADER CONNECTIONS

Principles of Operation

IF a closed vessel, which in this case is called the discharge chamber, be placed above a boiler and connected to it by 2 pipes, one to the steam space and the other below the water line, the pressure in the closed vessel will be the same as in the boiler and the water in the pipe connected below the water line will stand at the same level as the water in the boiler. If a vent pipe on the closed tank be opened the pressure in the closed chamber will be decreased and the water will rise in the one pipe high enough to make up the difference in pressure between that in the closed vessel, and that in the boiler, and steam will flow through the other pipe into the closed vessel in its effort to equalize the pressure between the boiler and discharge chamber or closed vessel. If the steam rising to the discharge chamber holds water in suspension this water will be swept along with the steam to the discharge chamber where it will fall to the bottom of the tank and into the return pipe which is connected below the water line of the boilers and increase the head or height of water in this line. This extra head of water overbalances the increase in height due to the difference in pressure between the boiler and discharge chamber and water will flow into the boiler until the former level is reached. This action causes the slugs of water and steam, or rather a spray of water and steam, to rise from the receiver to the discharge chamber where they separate, the water falling to the return pipe and the steam condensing with a little of it blown out the vent pipe to reduce the presure. To further aid the operation a check valve is placed near the boilers in the return line which will prevent the water of the boiler from rising in the return line if the other side of the system should become broken or be closed, the check valves also have another use which will be explained later on.

Piping

CONNECTIONS are made to the bottom of the steam line at all points where it is possible for water to settle, and the condensation is carried to a receiver located below the lowest point of the steam line, there is also a ½-in. equalizing steam line connected to the receiver from the main steam line. From the bottom of the receiver is connected a 1½-in. riser in which long bends are used in place of ells and through which the slugs of water and steam rise to the discharge tank located 35 ft. above the water line of the boilers. In this tank the water and steam enter the top and the return to the boiler is taken from the bottom.

There is a ¾-in. vent pipe taken from the top of the discharge chamber and run down to the exhaust pipe or heater with a regulating valve and a telltale placed in such position that it can be readily seen.

The use of the vent pipe is to take off any air or non-condensible vapors and also to reduce the pressure in the discharge tank. As this vent blows into the heater any steam blowing through the regulating valve is utilized in heating the feed water. If for any reason the return is shut off or becomes stopped up

the discharge tank will fill up and water will come through the vent pipe and will blow from the ¼-in. telltale cock and be noticed by the engineer.

Steam Pipe System

IN Fig. 1, which is a plan view of the piping of the plant and also shows the location of the boilers and engines, it is seen that the main steam line forms a loop around the boilers and engines with gate valves so placed that in event of failure in any part of the system this can be cut out and repaired without a shut-down of the plant which runs 24-hr. a day. The steam line is set as nearly level as possible and crosses be cut out. There is also a ½-in. bleeder or open blow, as it is called, for the purpose of draining the steam from that section in case of repairs or accident.

On the main steam line in the engine room crosses are used to take off the branches to the engines, to the bottom of which is connected a ¾-in. drain to header No. 1 which is placed about 1 ft. below the steam line a little to one side.

Each connection is made by a nipple, tee, nipple and valve with a bleeder from the tee to be used in case one section of the steam line is to be cut out for repairs. The connections are shown more in detail in Fig. 2. The drains from the separator on the engines

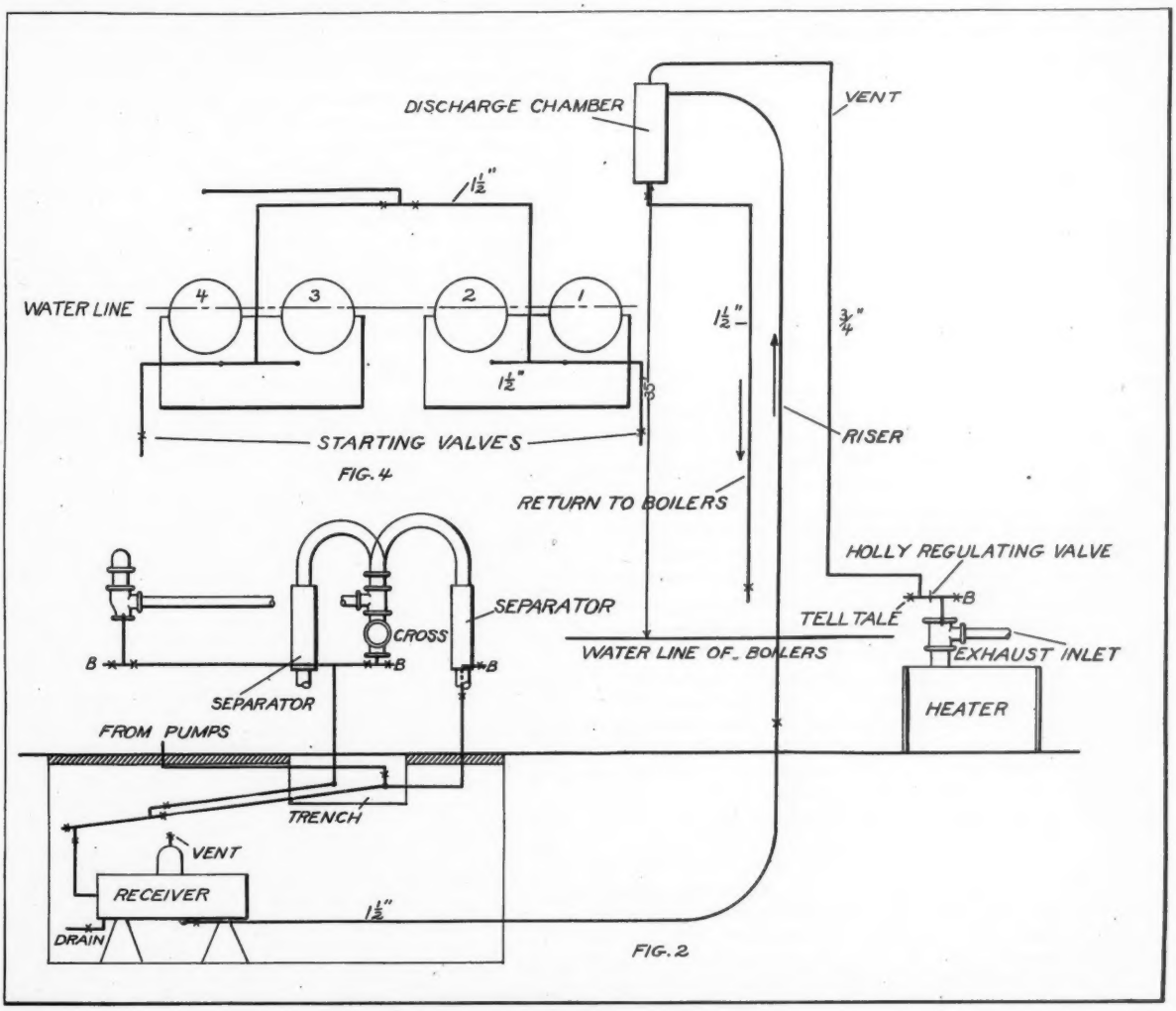


FIG. 2. END VIEW OF PIPING SHOWING DRIP CONNECTIONS
FIG. 4. DETAIL OF RETURN PIPING

are used in place of tees for the outlets to the bottom of which the drip connections are taken as shown in Fig. 2. The boilers are connected to the main 9-in. steam line by 9 by 9 by 6-in. tees with a gate valve near the tee and an angle valve on the boiler outlet, the long bend being horizontal on account of lack of head room.

From the bottom of the tees a 1-in. pipe runs to drip header No. 1, this is shown more in detail in Fig. 3, a valve is placed near each connection to the line and also each side of the drip header so that in case of accident to the main line or drip line that branch may

and pumps are carried down below the floor to header No. 2, because they are lower than header No. 1, and also, this brings them out of the way. A valve is placed in each line near the separator also a ½-in. bleeder. Header No. 2 is placed in the trench beside the exhaust pipe.

A receiver is placed in a pit below the floor and both headers are connected thereto with suitable valves for cutting out and draining either line. The equalizing pipe from the header to the receiver is shown in Fig. 2. A ½-in. vent is placed in the top of the receiver for blowing out air in starting or to re-

duce the pressure in case of repairs. From the bottom of the receiver a 1½-in. pipe runs to the discharge chamber which is placed 35 ft. above the water line of the boilers. The object of placing the discharge chamber at this height is to overcome any siphoning action in the drain lines or receiver, thereby assisting the water and steam to rise in the same manner that lowering the pressure in the discharge chamber would, no fittings are used in this line all turns being made by bending the pipe in order to reduce friction and eliminate steam or air pockets. The discharge chamber and pipes connecting it are placed in a pipe stack and are therefore out of the way.

The return pipe is connected to the bottom of the tank and passes from the pipe stack, near the ceiling of the engine room, to the back of the boilers where it branches and a connection is made to each boiler below the water line with a check valve and 2 gate valves the main return and branches are all 1½-in. pipe. Fig. 4 shows the return piping more in detail also the 1-in. starting valves located at each end of the return line near the side of the boilers. Only one starting valve is required to start the system but 2 are used so that in case of trouble either can be used. A ½-in. open blow or bleeder is placed at all points marked B, the use of which is stated above.

Operation

TO start the system, open all valves into the drain header and receiver, with all valves to the atmosphere closed, leave the vent on the receiver open till the air is blown out also the open blow on the vent pipe until steam blows out, then open one of the starting valves and blow all the water out of the line or until steam shows, then shut the starting valve and open the valves to the boilers and the system will be in operation as long as there is steam and will work indefinitely without further attention.

The regulating valve in the vent pipe is opened a very little and the steam escaping through it assisted by the siphoning action due to the weight of a column of saturated steam 35 ft. high reduces the pressure in the discharge chamber. This steam goes into the heater and therefore is not wasted. The telltale or pet cock is partly closed and allowed to blow into the atmosphere and should be placed so that it may be easily seen by the engineer or fireman and will blow dry steam as long as the system is working but should a valve on the return line be closed the water in the discharge chamber will rise and overflow into the vent pipe and water will come from the telltale thereby warning the engineer that the return side is shut off. If a valve at the receiver or in the riser is closed there will be no blow from the telltale showing that the trouble is in the steam side of the system. Water from the boilers is prevented from rising to the discharge tank by check valves at the boilers.

In the case under consideration, when a boiler is cut in or out of service the return connection from the main line is opend or closed at the same time, but in case it is desired to return all the condensation to one of the boilers the valves leading to the other boilers in service are left closed. The check valve placed at this point also prevents the water passing from one boiler to the other in case of a difference in pressure or water level.

All valves should be gate or straightway in preference to globe valves especially with the horizontal drain pipes and riser, also wing check valves should be used.

All tanks, pipes, etc., except the vent pipe are covered with standard pipe covering to prevent radiation and the water enters the boiler at a very high temperature.

The vent pipe is left bare in order to increase condensation which aids the siphoning action of the vent to reduce the pressure in the discharge tank.

The disadvantages of the system are high head room and a large amount of pipe which will increase the first cost, this is off-set by the advantage of having a system of drainage for the high pressure lines that is at all times in working order, requires no attention, after starting, has no moving parts to stick, requires no oiling or adjusting and requires very little steam and that is returned to the boiler with the feed water, the water is returned directly to the boiler at a very high temperature, and if the system is properly installed will last as long as the steam lines. In the case described at least 2 large steam traps would be required to take care of the condensation and then would have to be pumped from the heater to the boiler.

While this installation is only one case among many in which the steam loop and gravity return system can be used, it shows a very successful plan and one that is giving good satisfaction to those in charge.

AUTOMATIC MOISTURE CONTROL

By Charles Mandeville

ALLIED to the thermostatic system is that of the humidistat, or the controlling of the moisture and which has been widely applied in connection with our most modern systems for heating and ventilating.

When indirect heating is used, where air is drawn over tempering coils and forced through ducts to delivery points, the air delivered is often very dry, so dry as to be injurious to our lungs.

Air at any ordinary temperature contains moisture in the form of vapor, the amount depending upon the temperature of the air, not in direct proportion but in increased proportion. Water in the air is necessary both for the growth of animal and of vegetable life. The human body is constantly giving off moisture from the skin and lungs and this process is very important to the preservation of a healthy bodily condition.

Now that we have settled that air which is very dry or that contains a low percentage of moisture will produce bodily discomfort and eventually ill health, it has remained for our scientists to settle for us that a relative humidity of 60 or 70 per cent is about the most comfortable for our living rooms. The humidity or dampness of the air does not depend alone upon the quantity of aqueous vapor present but upon the nearness to the saturation point. The moisture necessary to cause saturation increases rapidly with the temperature. Therefore the quantity of water that would saturate the air at a low temperature would only partly saturate it at a higher temperature. We say that the air is damp when it is nearly saturated with vapor.

Heating air, while the quantity of vapor remains unaltered, removes it farther from the saturation point and diminishes its dampness. When damp air from out doors passes through tempering coils it

becomes dry air; not because it has lost any of its moisture, but because its capacity to take up water vapor has increased with the rise in temperature. The requisite amount of moisture is then much greater and it is necessary to add more water vapor to bring the rooms nearer to the saturation point. Humidity is therefore expressed relatively as the proportion of the water vapor present to the total amount required to saturate air at that temperature and pressure. If air containing water vapor be gradually cooled, a temperature will at length be reached at which the vapor will begin to condense. This point is called the dew point.

Humidistat System

VENTILATING experts have put an extra coil of pipe in the heating chamber where our regular tempering coils are, just at the beginning of the ducts or passages leading to the rooms to be heated. This extra coil of pipe is put into a sheet iron pan. The pressure of the steam used in this extra coil is usually somewhat higher than that used in the tempering coils proper; it has been found good practice to carry about 20 lb. pressure in order to get the benefit of the additional heat units in the steam at higher pressure.

There is placed beside the pan holding the heating coil an ordinary plumber's cistern fitted as usual with a float valve or ball cock and piped to some water supply source. This cistern is set at such a height as to maintain a constant level of water, enough to cover the steam coil in the humidistat pan, into which it discharges its water.

Comparison of Humidistat and Thermostat

IN the room or duct where it is desired to maintain a uniform humidity of the air, the humidistat is placed. This instrument is in construction and action identical to that of the thermostat described in the March issue, with one exception; the small expansion strip of the thermostat is made of brass and steel while in the humidistat it is made of a piece of wood of a kind which is highly sensitive to the action of the moisture contained in the air surrounding it, sugar maple is commonly used. The statements in regard to air supply, control valves, and piping of the thermostat will all apply to the humidistat.

In order that we may know what the humidity of the air is, there must be provided an indicator or measuring instrument called a hygrometer. It consists of 2 thermometers arranged on a board with a scale or table of figures and lines between them. The bulb of one of the thermometers dips into a small trough which is kept filled with water. If the surrounding air is not saturated, evaporation will occur from the wet bulb and the constant abstraction of heat will lower the temperature below that of the surroundings. After a little time the wet bulb will indicate a temperature constantly below that of the dry bulb by an amount depending upon the humidity, since the rate of evaporation is determined by the amount of water vapor present in the air. The scale on the board is made to show by means of a traveling pointer or movable arm just what humidity the thermometer readings show to be existing at the place where the instrument is set.

There is one feature to be noted in connection with this system: as heated air will hold more water than cooled air, if we heat the air supply and load it up with 75 or 80 per cent of all the water it will take, we must be careful to avoid lowering its temperature, either on the way to the point of delivery or at the delivery point itself, otherwise excessive condensation will occur.

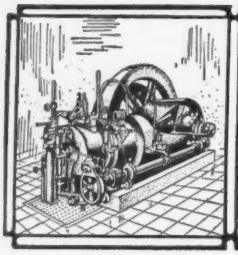
In operating this system it is necessary to arrange so that the steam supply to the humidistat coil is not controlled by the automatic valve until the heated air has been circulated for some little time, say 15 min., and that the steam supply is shut off from the automatic valve before the tempered air supply is shut off. This regulation of steam delivery is done by a hand-controlled valve placed on the reduced pressure steam pipe behind the automatic air-controlled valve controlled by the humidistat. Notice here that this is an essential feature in the operation of this system and must especially be attended to where the heated air is forced through ducts or passages by mechanical blowers or fans.

In connection with the compressed air supply there has been an arrangement made to guard against this danger of excessive humidity. In the ordinary action of the compressed air controlling valve in both thermostatic and humidistatic systems, when the air goes on the diaphragm valve the valve shuts. In case a pipe should break in this system or should the compressor fail to keep up the required pressure, the entire system of control valves should remain wide open. Now while in a system of thermostatic control of heating alone this condition can be tolerated in such an emergency, in the case of the humidistatic system there is a difference. Should the automatically-actuated steam supply valve to the coil in the moistening pan remain open the water supply to the pan is automatically maintained and the steam coil would get all the water it could boil and would boil all it could get. In a short time there would be clouds of steam going through the air passages and condensing in the rooms supplied.

In order to prevent such an accident there has been arranged for this system the scheme of putting 2 air-controlled valves in the reduced-pressure steam line supplying the coils in the humidistat pan, one valve being immediately behind the other. One valve is so connected that the steam pressure is underneath the valve seat, so that when the air supply is cut off from the diaphragm valve the pressure of the steam forces the valve open. This is the ordinary action of these valves. The other valve is piped so that the pressure comes on top of the disk, when the air pressure acts to hold it constantly open against the steam pressure. The air line to this second or emergency valve is taken directly from the main air coming from the receiver and is not controlled by an instrument, hence in case the main line pressure fails the valve will be shut by the steam pressure, aided by the spring around the valve stem.

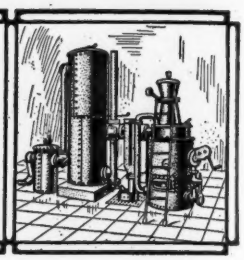
EXPERIMENTS HAVE BEEN made by the United States Bureau of Mines at the Pittsburg experiment station to combine with coke as a fuel, limestone in such proportions as to flux the ash and form a liquid slag. This has been successfully done and the slag now runs freely from the producer, avoiding clinker and ash troubles with consequent shut-downs. Another advantage is the production of a high temperature in forming the slag which is very efficient in the generation of gas.

THERE IS QUITE a difference between earning money, making money, and getting money. The first may be called honesty, the second speculation, and the third robbery.—System.



Gas Power Apparatus

Producers, Engines and Industrial Applications



THE SYRACUSE PRODUCER

WHILE producer gas as a source of power for industrial purposes has been in use scarcely 10 yr., the increase in total horsepower of producer gas plants has been remarkable. This rapid increase is unusual since the producer outfit is a radical change from former kinds of power plants. The principal cause of its extended use is due to its economy, but there are a number of other items such as safety, no chimney or smoke, less labor and less space, which have worked together to make the producer gas plant the choice in many instances.

One of the difficulties which the designer has encountered has been to construct a producer which gives a rich gas immediately upon starting the engine. One of the more recent types of producers placed upon the market is the Syracuse Gas Producer, made by the Syracuse Industrial Gas Co., of Vernon, N. Y. These producers are built in capacities from 300 hp. to as low as 10 hp. The principles of operation of this type of producer are essentially the same as in the other types which operate on the suction plan, the principal difference being in the matter of construction details, method of generating steam and method of starting.

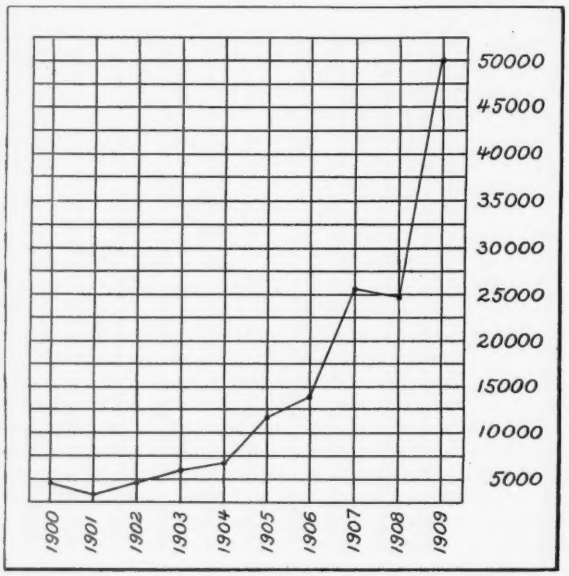


FIG. 1. GROWTH IN HORSEPOWER OF PRODUCER GAS POWER IN THE UNITED STATES

The top and sides of the producer are inclosed with double shells between which the entering air is heated and the steam generated. The gas is drawn from the producer through scrubbers which cool and clean it, then directly to the engine cylinder, and no storage is necessary. Upon each suction stroke of the engine, gas is drawn into the cylinder from the top of the producer, air and steam entering at the bottom to take its place. As the governor cuts off gas from the engine, the air and steam entering is diminished so that the generation of gas is always in proportion to the load.

Operation

TO start the producer, a fire is built as in the ordinary furnace, the draft being furnished by an exhauster operated by hand or power. The use of an exhauster here instead of a blower prohibits any chance of a leakage of gas anywhere in the plant. After the fire is well started, steam is mixed with the entering air and soon a combustible gas is being generated. When the gas burns well at a test cock near the engine, the exhauster is stopped and the engine started. The generation of gas now proceeds automatically by the drawing of the air and steam through the fuel bed, and the resulting gas through the balance of the system, as a result of the suction caused by the engine.

Further attention is seldom necessary until the plant is shut down for the night. During the night, and in fact for several days at a time without attention, the fuel bed remains hot and good gas may be developed in a short time.

Details of Construction

TAKING up in detail a description of the Syracuse producer, we refer to the sectional view Fig. 2. The charging hopper is perfectly tight, thus insuring against inleaking of air, it is easy to operate, and affords no chance for the attendant to make a mistake. It consists of a double valve arrangement, the lower valve being a metal slide and the upper one a sheet metal cover, closed air tight by a water seal around the bottom edge. The handle operating the slide valve is fastened to and removed with the cover, and arranged so that before the cover can be removed the slide valve must be shut tight.

Both the producer top and sides are enclosed with a double casing, the outer one in each case being easily removed. In order to carry enough steam for making good gas the ingoing air supply is drawn through this double shell arrangement, thus heating it to a temperature of about 158 deg. This not only keeps the producer room cool, but the heat which ordinarily escapes by radiation from the single shell is taken up by the incoming air and carried back into the fire.

Steam supplied to the fire is generated from the heat in the gas as it leaves the top of the producer. In this way the gas is partly cooled before entering the scrubber, and completely cooled and cleaned with less water than would otherwise be needed.

Ashpit and cleaning doors are entirely of cast iron which is not easily rusted or corroded by contact with wet ash. The grate is of the shaking type operated from the outside, and the grate bars are selected to suit the proposed fuel in each case. This grate allows even descent of the fuel over the whole area and keeps the middle of the fire as clean as the edge.

Steam Supply

DIFFICULTY in the operation of producers is usually experienced when starting up in the morning. This is because an insufficient amount of steam is supplied. To overcome this difficulty the upper part of the cast-iron base in the Syracuse producer

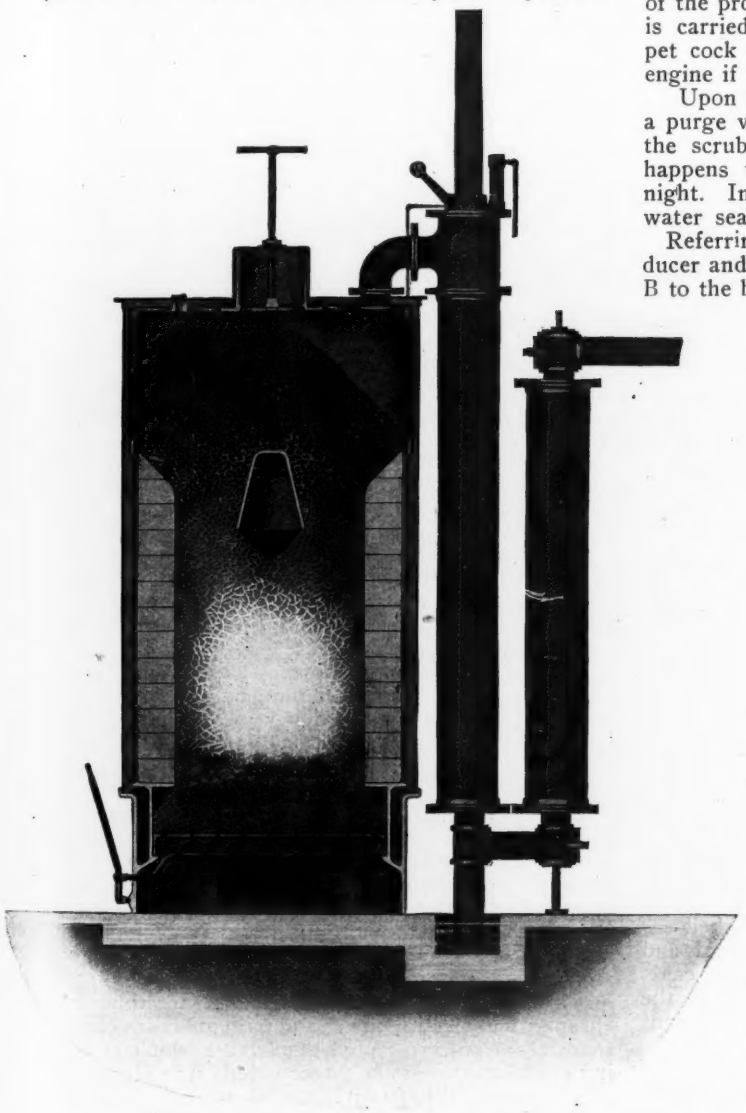


FIG. 2. SECTIONAL VIEW OF LARGE SIZE SYRACUSE PRODUCER

is a water compartment used principally for starting. By this arrangement the water not being evaporated at first as usual in the top generator overflows into the compartment around the grate. The latter being hot the water is here evaporated into steam until the outgoing gas having become hot enough causes the top generator to do its normal work.

In Fig. 3 is shown the regulator which supplies water to the vaporizer in proportion to the load on the engine. There are no moving parts to this regulator which are apt to get out of adjustment, and all passages may be inspected or cleaned when necessary.

The regulation is as follows: The suction of the engine upon pipe A is necessarily always in proportion to the load. The water stands at level B in pipe C when the engine is not running, but rises to some point D when half load is on engine and to some higher point E when full load is on engine. The slot in the upper part of pipe C allows the water to run out in proportion to the height to which it rises. This water runs out from pipe F into the top of the producer, where it is generated into steam and is carried into the fire with the ingoing air. The pet cock G is used to neutralize the suction of the engine if necessary to any required degree.

Upon leaving the producer the gas passes through a purge valve which automatically closes the pipe to the scrubber when the pipe to the air is open, as happens when the producer is shut down for the night. In this case the purge valve is water cooled, water sealed and will not stick.

Referring to Fig. 4, gas enters at A from the producer and when the engine is running passes through B to the baffle scrubber. Water to supply this scrubber enters at D and after passing through the valve flows out through the series of holes near the top of the valve and thence through B into the scrubber. When the engine is not running and it is necessary to open the valve to atmosphere, the disk F is dropped over B. This allows the water to flow out of the valve, leaving the producer thus open to the atmosphere.

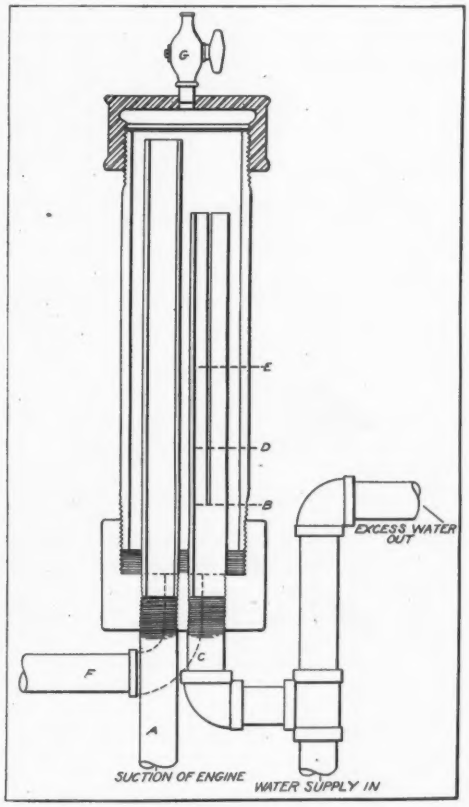


FIG. 3. WATER REGULATOR

In order that the first part of the water from the engine jacket may be re-used for cleaning the gas, a double baffle scrubber is employed. A small quantity only of cold water is needed in the second part, since a large part of the heat in the gas and most of the dirt has been removed by the hot jacket water in the first.

The method of starting is one characteristic of the Syracuse producer. Connected with the gas pipe near the engine is a small exhauster, and during the time of drawing up the fire to the gas making stage the same conditions are maintained as when the engine is running. By reason of this method full load can be thrown upon the engine immediately after starting.

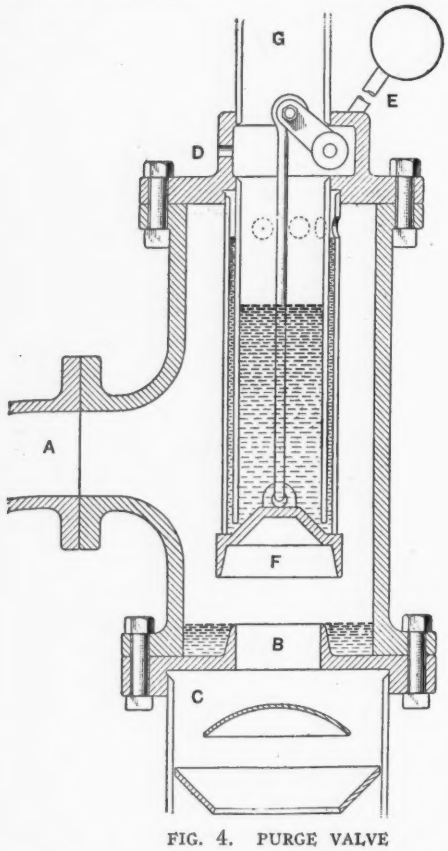


FIG. 4. PURGE VALVE

In the small sizes, 10 to 30 hp., a double shell encloses the sides, and the vaporizer is internal and near the top. The tower scrubber is filled with coke, through which the gas must pass in going to the engine. The coke is kept wet by a small amount of water being sprayed in at the top.

A SMOKE UNIT corresponds to 1 min. of No. 1 smoke; thus 1 min. of No. 2 smoke is equivalent to 2 smoke units; 2 min. of No. 3 smoke, 6 units; 4 min. of No. 1, 4 units. The Ringlemann chart is used as standard. A stack minute corresponds to watching one smoke stack for one minute.

WHERE AN ANNEALED copper gasket fails to make a tight joint, try wrapping the gasket with heavy cord or wicking. Soak the wrapped gasket in valve oil. When the gasket is again inserted you will have a permanent repair.—Popular Mechanics.

WHY?

BY H. W. JONES

AS I received it the message was to this effect: "Kindly call at the ———— Co. and give particulars as to size and cost of installing, also an estimate of operating costs, of a gas engine on natural gas."

It is needless to say that very shortly thereafter I arrived at the door of that company's office, presented my card and was ushered in.

The manager made it plain that he was glad to see me, listened with flattering attention to my story and then took me through the building, explaining to me his needs in the power line, he and I alternating in explaining matters that attracted our attention.

I had been called on such expeditions before and knew that this was a gas engine proposition from both economical and engineering standpoints. The conditions were Gas Engine. There is no use going into details. But space, need, and cost all plainly said "Gas Engine." The manager was much pleased with the plan of installation and especially with price and cost of operating.

On our return to his inner office he remarked to me that the consulting engineer would let me hear very soon as to size of engine He would recommend.

"Is there a consulting engineer on this job?" said I.

"Why, yes. Why do you ask that?" he replied.

"Good bye," said I, "for I'll never see you again," and I never did.

If this was the first case of the kind, or second, or third or fifteenth, I'd probably say nothing, but it's getting to be an old story, and I want to know Why?

The writer does not claim to be "too honest," but he has recommended against gas engines himself when the case was one where other power was better. The question is, Why do consulting engineers never recommend gas engines?

I have seen electrical men, salesmen of central station power, also steam engine engineers advise the installation of gas engines, but in now nearly 8 years I have yet to see or hear of one gas engine being installed—or recommended to be installed—by a consulting engineer.

Of course, there may have been such cases; I'm only telling my experience which has been entirely with city gas and natural gas, with now and then a producer outfit slipping in. With natural gas at 40 cents a thousand feet, a horsepower can be delivered for less than 1 cent; with city gas at 85 cents a thousand, for less than 1¾ cents. Both can be done, and are being done, without any special care.

Now we know that this is about 20 to 50 per cent cheaper than electric power and in many cases cheaper than steam power. Why, then, I ask, don't consulting engineers occasionally recommend it? There must be a reason. What is it?

I am talking about power now, not heating. Again, I am talking about small installations, 25 to 175 hp., where space is valuable, where conditions are right, where but one engineer is required and where he is needed at other more valuable work than shoveling coal and wheeling ash.

And what are operating engineers thinking about when they see, or ought to see, that a steam engine and boiler in their plant are not what occasion demands? Are they, too, not blind to their own interest and to the interest of those who pay them for their

skill, when they seemingly will not listen to gas engines but do listen to other power that means higher cost to their employers and a body blow to their profession.

I know many former steam engineers who are now enthusiastic gas engine engineers. I know a few, very few, well known, high class, engineering publications that publish many valuable facts about this power that are not given credit for the good they conscientiously try to do.

This article does not in any way mean to belittle other power. Even granting that gas power is the least deserving of consideration, it must certainly be entitled to its share, which it is not given by the engineering profession.

Our colleges do not give to this question of gas power the attention the matter deserves. Go into any of these schools and find a modern up-to-date gas engine if you can, one that is up to date in construction and equipment. And I desire to ask, Why not? Should not the coming engineer be partially posted on power of every kind? Is it not the duty of these colleges to instruct the "coming man," and is it fair to him to permit him to go forth into the world with little or no information as to gas power, its advantages, as well as what is needed to bring this power up to standard if it is not there already?

I know of numerous cases where salesmen are wanted, who have technical training in power-producing agents and power transmission and who know something about internal combustion engines, men who can explain in a mechanical way a man's power requirements. Why are these men not turned out by our technical schools?

Try this. Ask any of the graduates of a school of engineering, questions as to the proper equipment of a gas engine. Ask them what appliance to install to utilize the waste heat from the exhaust, or for a method of utilizing the water, or for a sketch of a water superheater; and then ask steam engineers; and last ask a consulting engineer; and then you will not blame me for being an ignoramus myself.

Here is where consulting engineers can be excused. They possibly may never have been informed and the only experience that they have had has been with engines that were wrong at the start, installed wrong, equipped wrong and operated wrong. But the world of mechanics today demands better things, and to these men we have a right to look for real information; but they have it not, otherwise they would know gas power better, and benefit themselves and their clients by this knowledge.

There should be a chair of Internal Combustion Engineering in our colleges and a laboratory equipped with up-to-date appliances giving practical demonstration of scientific Gas Power to our sons and brothers.

Engineers fear, and justly, the encroachment on what they consider "their preserves" by Central Station Power, and yet they will deliberately condemn a gas engine on account of failures and overlook the reason of such failures and their successes.

Even were it true that there are no successful gas power plants today, how about tomorrow? Does anyone dare deny the possibilities, and are we, the real friends of engineers, to be condemned practically on account of the failure of our engineering educational institutions to furnish us men to carry on the work?

"Engineer" formerly meant little; today Engineer means a mathematician, a chemist, a scientist, a diplomat and a gentleman. Gas power can be added to these lines and offers today opportunities that steam power does not and that central station power cannot compete with.

Gas power has made good with the user and stands ready to do so with the consulting engineer as well as with the operating engineer; but it must be given a chance. Gas power stands ready to prove its worth, is proving its worth, and the neglect of those who should be its friends is the reason I ask "Why?"

That gas power is a success is easily proven, but if it is a failure, it is easily accounted for, viz., lack of engineering ability in the installation and operation of the plants.

Again, does a buyer realize what a gas engine really should be, and when this buyer calls in an engineer, does the engineer realize it? The writer claims that the lack of proper equipment is a bad thing. But what is proper equipment and how is the buyer going to find this out? Remember there is a standard that is right. Each installation is a separate engineering problem and whenever a prospect calls in a consulting engineer, that settles it,—no gas engine. And again we ask, "Why?"

Irrespective of what anyone may say, there is a field for gas engines. Is it possible that this field is so small that engineers can't see it? Is it "Engineering" to advise the installation of the very thing that has a tendency to narrow the field of engineering where the only reason for such advice is that the adviser is behind the times in not knowing that gas engines are reliable, are efficient, are economical? And that an installation under consideration belongs in that field referred to that engineers seemingly have never been able to see? In this immediate district, there ought to be one of these once in a while, but they don't seem to materialize.

Why not?

POINTED INJUNCTIONS

DON'T mope; when you don't know what to do, ask somebody. Don't ever give up; when you think you're licked, take a deep breath and keep on hammering. It probably needs only another blow or two to win.

Don't be too fond of patience; she drives better hitched double with push.

Don't take something "just as good"; know what you want and make sure that you get it.

Don't worship ideals and fads; a long line of common sense helps most in the day's work.

Don't try to get the best of a salesman; and let him get the best of you. In a fair bargain, both sides are benefited.—Adapted from The Automobile.

AN INTERESTING DECISION of the Supreme Court of New York has to do with the attachment of wages by loan sharks. The ruling is that employes' wages cannot be filed upon by writ executed with the employing company. In this connection a step taken by several prominent firms providing for the making of temporary loans to employes in cases of emergency is a commendable proposition, as it takes care of emergencies which will sometimes arise and avoids the opportunity, on the one hand, for oppression of the employe, and on the other hand for friction between the money lenders and the employers.

IN THE SESSION of Congress just closed a bill providing for the inspection of locomotive boilers was passed. The bill was approved by both the railway labor organizations and the railroads themselves and with such backing should lessen considerably railway accidents.

SOURCES AND METHODS OF PRODUCTION OF LUBRICATING OIL

By W. A. Converse*

THUS far the writer has only in a general way called the attention of the reader to the source, production, composition and processes of distillation and refining of crude petroleums, assuming now that we have reached a point where the finished products should demand some attention or comment. Therefore, the writer cites a few things that he believes will prove of value to any one upon whom the duty of selection of suitable lubricants falls, giving our attention first to oils for steam cylinder lubrication.

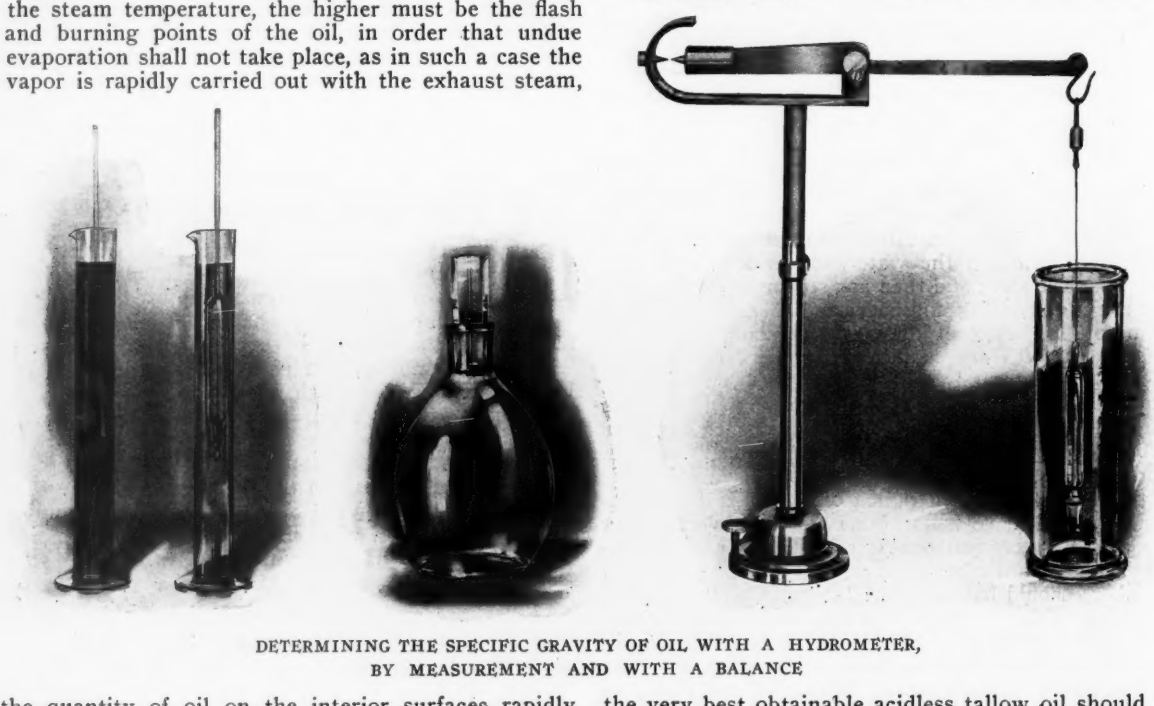
In selecting an oil for steam cylinder and valve lubrication, it is vitally necessary to have a complete understanding of the conditions under which it is to be used. To obtain the best and most economic results, we must, at least, take into serious consideration the properties of both lubricant and steam.

The steam pressure, or, better still, the internal temperature of the cylinder, and the moisture contained in the steam are important factors. The higher the steam temperature, the higher must be the flash and burning points of the oil, in order that undue evaporation shall not take place, as in such a case the vapor is rapidly carried out with the exhaust steam, the quantity of oil on the interior surfaces rapidly reduced, and the lubrication more or less impaired, unless an excessive quantity of oil is constantly applied.

The viscosity of the oil must be such as to warrant its atomizing readily at the temperature of the steam, in order that it will reach all parts of the cylinder, as the piston and often the valves move to and fro in straight lines and do not tend to trap automatically the oil properly and keep the surfaces from touching. An oil of too high flash and burning points and viscosity will not give proper lubrication, any more than one where they are too low. In cases of comparatively high temperature in the cylinder, and practically dry steam, a pure mineral oil will usually give the desired results, but as the steam is more or less wet, it becomes necessary that some vegetable or animal oil or fat be added thereto, to take care of the moisture.

A pure mineral oil will not lubricate satsfactorily where there is much moisture, due to its inability to adhere sufficiently to the wet surfaces; while, on the contrary, some animal fats readily emulsify with the moisture and adhere to the surfaces. For this reason, we find it essential that most steam cylinder oils contain a sufficient amount of an animal fat to overcome the effect of the moisture. As the animal fat is prone to become rancid (acid) under such conditions, it is imperative that none other than the very best obtainable acidless fat be used.

We have, in a pure acidless tallow oil, one which is especially adapted to such use; in fact, nothing but the very best obtainable acidless tallow oil should be used. No greater percentage of tallow oil should be used than is necessary to accomplish the results desired; when present in excess it impairs lubrication rather than improves it. As in alloys of metals, to obtain a perfect product, it is necessary that the proportion of constituents used should be properly adjusted and thoroughly blended and mixed.



DETERMINING THE SPECIFIC GRAVITY OF OIL WITH A HYDROMETER, BY MEASUREMENT AND WITH A BALANCE

Engine and Dynamo Oil

IN selecting an oil for engine and dynamo lubrication, greater attention should be paid to the viscosity than to any other property. The viscosity should be sufficiently high to assure the proper filming of the oil, in order that the rubbing surfaces will be kept apart at

*Chemical Director of the Dearborn Drug & Chemical Works.

all times while in motion. The viscosity must not, however, be so great that the thinnest film possible for the oil to form will not permeate the slight space between the moving surfaces; on the whole, the slower the speed the greater should be the viscosity. Save in exceptional cases, a pure mineral oil will give the best results.

Oils selected should be absolutely free from grit, tarry matter and acids of any kind. They should be of comparatively light gravity—29 to 31 deg. Beaume—have a flash point of not less than 400 deg. F., a burning point of not less than 440 deg. F., and a viscosity from 170 upwards, as the case demands. They should be strictly products of the best paraffin-base crude petroleum, distilled by the wet or steam process, properly refined (without the use of acids and alkalies), thoroughly debloomed, paraffin wax removed, and filtered through animal charcoal (bone black) or Fuller's earth, to the desired color and perfect transparency.

Animal and vegetable oils or fats are objectionable in engine and dynamo oils (except for marine engines), as when exposed to the dry atmospheric conditions in practice, they become so decomposed, or changed, as to become more or less gummy, in which condition they readily attract any dust or grit in the air and become objectionable and of no lubricating value.

In cases where the fat becomes acid, the latter attacks the metal of the bearing, forming what is known as metallic soaps,, which, being soluble in the mineral oil, are taken up, the continuation of these conditions resulting in corrosion of the surfaces.

In case of marine engine lubrication, it is necessary to use an oil compounded with lard oil in order that it shall readily emulsify with the large amount of water with which it comes in contact (as water is usually kept running on the bearings, and a pure mineral oil would readily wash off). But with a proper pure mineral oil, compounded with 25 to 35 per cent of best winter-strained lard oil, the desired emulsification is obtained, the mixture of oils and water adhering to the moving surfaces and giving satisfactory lubrication.

Physical Properties of Oil

SINCE the process of lubrication is a physical and not a chemical one, it is possible to judge the quality as well as the adaptability of a certain oil to use under certain conditions, by determining the physical properties, together with a few minor analytical determinations, such as the determination as to whether or not the oil is a pure mineral, or compounded one; and, if the latter, the amount and kind of animal or vegetable oils contained, together with an examination for acidity, the presence of residue or tarry matter.

The necessary physical properties to be noted are the gravity, flash point, burning point, viscosity, cold test, and, ofttimes, coefficient of friction. This being the case, the descriptive matter pertaining to the apparatus and methods for determining these several physical properties following, will undoubtedly prove of material interest to the reader.

Specific Gravity

THE gravity of a liquid or solid substance is the weight of the substance as compared with an equal volume of water at 60 deg. F. The gravity of lubricating oils being lighter than that of water, their specific gravity is less than one; for example, assuming that a pint of distilled water, at 60 deg. F., weighs 1 lb. and a pint of oil weighs but ¾ lb., the specific gravity of the oil would be 0.75.

In commerce, however, the gravity of lubricating oil is given in degrees Beaume according to a conventional scale adopted by refiners and marketers of oils, in which water is taken at 10 deg. Beaume as a standard. In case of specific gravity, the higher the numerals the heavier the oil; while by Beaume scale, the reverse is the case; that is, the higher the number of degrees quoted, the lighter the oil.

The gravity of a lubricating oil is of small value in determining the lubricating value thereof, when considered by itself, but it becomes important in connection with other tests, viz., flash point, burning point, viscosity and cold test, as it enables us to determine with considerable certainty the origin of crude petroleum from which it is produced; also in detecting the presence of rosin and coal-tar oils, which are objectionable.

There are 3 practical methods for the determination of the gravity of an oil; first, by the use of a hydrometer; second, by use of a bottle which holds a definite amount of water by weight, at 60 deg. F.; third, specific gravity balance. All of these are shown in the illustration.

(To be continued.)

SHOULD-BE'S

By E. H. Marzolph

THERE should be a water circulator always put in a boiler of the same form as a siphon so that when the boiler is to be blown down the circulator is started and this draws the mud from any particular place and causes rapid circulation as the blow-off is opened.

There should be a perforated pipe the full length of the boiler connected to the blow-off pipe with perforations on the bottom to take away the sediment.

There should be water gate valves on the water end and steam end of the column pipe between boiler and water columns, to cut off connection in case of accident.

There should be steam traps on all steam lines.

There should be a trap on each compressed air line to take up the water of condensation.

There should be connection taken from the top of headers always for air and steam lines to avoid carrying over water.

There should be insulating coverings on all steam lines.

There should be air chambers on all water lines.

There should be provision for expansion by an expansion joint variator or bends in all steam lines.

There should be vacuum chambers on all pumps.

There should be a check valve in working order on the discharge of every pump.

There should be 2 valves on blow-off to insure tightness.

There should be by-passes provided on all sides where possible to prevent interruption.

There should be an oil seal put in the air chamber of every pump or water line to prevent water and air from mixing and breaking the air cushion.

There should be ample drainage for all water and steam lines so that a joint can be made without the engineer getting scalded or soaked.

There should be automatic stop and check valves on every boiler to safe-guard against accidents.

APPLICATIONS OF LOW-PRESSURE TURBINES *

VARIOUS PHASES AND ARRANGEMENTS FOR SPECIAL CONDITIONS

By Edwin D. Dreyfus

WHILE THE LOW-PRESSURE TURBINE has been most generally used for increasing the capacity of plants consisting of reciprocating steam engines which are in good physical condition, there are sundry other special applications which, although less usual, are perhaps correspondingly the more interesting.

In view, therefore, of the important developments to be described, it is a safe assertion that the low-pressure turbine may be economically applied for increasing capacity in all types of plants using steam engine power, and ordinarily, irrespective of working conditions or location of the apparatus. Its adoption truly establishes a rehabilitation of the reciprocating engine; first, in preserving its appraised value and minimizing the total plant investment; and second, through combined operation, improving the steam economy to the present high standards.

It will be seen that if the design of the turbine and its auxiliary mechanism had been suitable for but a single rigid condition, this noted progress of the low-pressure turbine would have been considerably retarded. But there is a great variety of conditions to which the turbine may be adapted; these provide the intended scope of this paper. The theory and demonstration of the utility of the low-pressure turbine will, therefore, be only briefly considered in the accompanying appendix since they have hitherto been so well discussed.

Classification of Low-Pressure Turbine Installations

ADDITION to a well-arranged and symmetrical a. c. or d. c. power generating station, condensing or noncondensing.

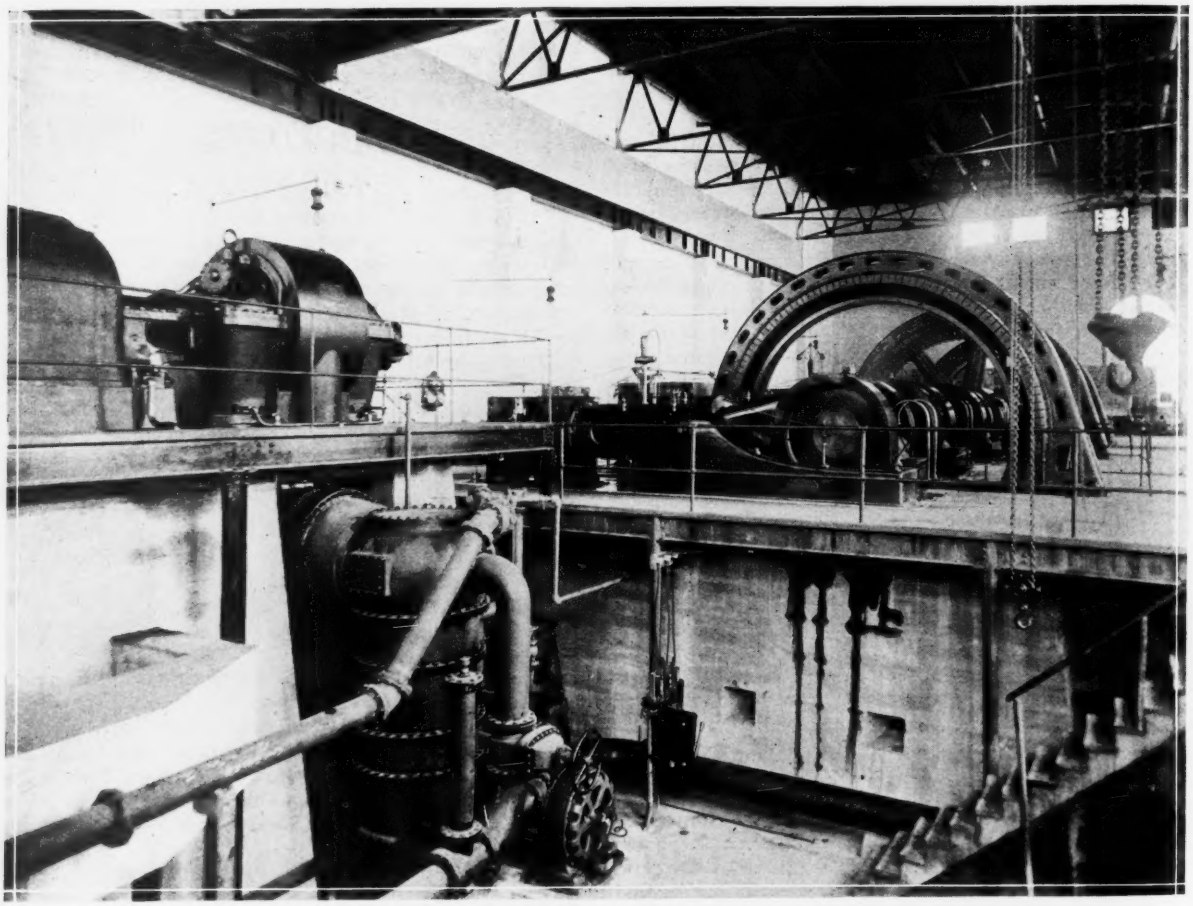


FIG. 2. INSTALLATION OF LOW-PRESSURE TURBINE WITH COMPOUND ENGINE

(b) Extension of poorly designed stations with dissimilar units.

(c) Increase for mills driven mechanically by main engine.

(d) Mills with widely distributed engines, demanding more power.

(e) Conservation of waste in intermittently operated and reversing engines.

*From a paper before the Providence Association of Mechanical Engineers.

(f) Variable a. c. electrical load for low-pressure turbine with uniform mechanical or d. c. load for engine, and vice versa.

(g) Utilization of gas engine waste heat.

Characteristics of Systems

THE nature of both the application of and the demand for continuous power from the low-pressure turbine, have, in the different cases above enumerated, evolved the following systems:

1. Turbine without governor.
2. Simple low-pressure turbine having governor control, with supplementary live steam admission valve.
3. Use of synchronous motor providing an electrical and mechanical tie with the main belt or rope wheel engine.
4. Governor operating valve bypassing steam to condenser.
5. Heat regenerators and accumulators.
6. Mixed flow turbine with high-pressure element.
7. Heat storage systems.

Combined Engine-Turbine Unit

THIS division proposes to cover what is to be considered the simplest type of plant, where the low-pressure turbine, with the engine, forms either a compound or triple expansion unit. The electrical interlocking of the engine and the turbine generators allows all governing to be cared for by the one regulator on the engine, the low-pressure turbine performing similar to a low-pressure cylinder with a fixed cutoff.

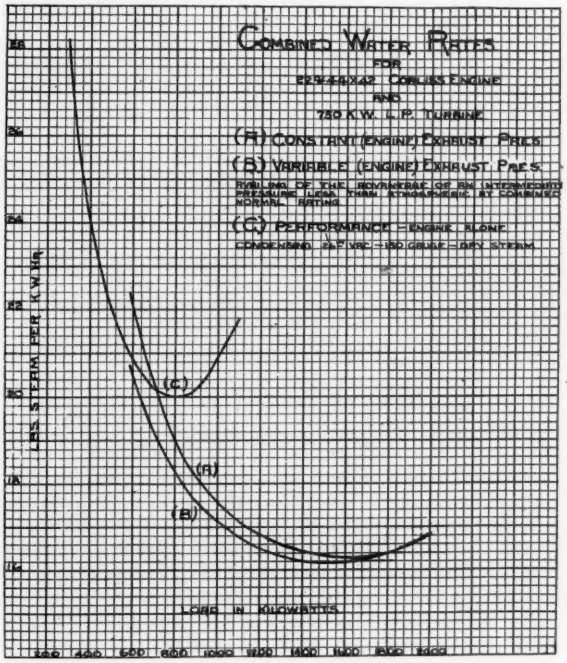

COMBINED WATER RATES
FOR
22"x44"x42" CORLISS ENGINE
AND
750 K.W. L.P. TURBINE
(A) CONSTANT (ENGINE) EXHAUST PRESS.
(B) VARIABLE (ENGINE) EXHAUST PRES.
RISING OF THE ADVANTAGE OF AN INTERMEDIATE PRESSURE LESS THAN ATMOSPHERIC AT COMBINED NORMAL RATING
(C) PERFORMANCE — ENGINE ALONE
CONDENSING 26" VAC. — 150 GRAIN — DRY STEAM
LBS. STEAM PER K.W.HR.
LOAD IN KILOWATTS
(C)
(A)
(B)

FIG. 1. STEAM CONSUMPTION CURVES SHOWING GAIN FROM VARIABLE BACK PRESSURE ON ENGINE

Fortunately for the compound engine (of large cylinder ratio especially), a variable back pressure is imposed, which does away with objectionable pressure loops on the card and pounding of the exhaust valves. In addition to this mechanical consideration, a gain in efficiency in the neighborhood of 5 per cent is realized, due to the more economical intermediate pressures established for the varying loads, as brought out in Fig. 1.

Evidently with a long and non-air-tight exhaust system, variable pressure operation would not be recommended. The practice of allowing the pressure between the engine and the turbine to fall below atmosphere was looked upon by some designers and operating engineers with disfavor at the outset, but experience gained in many low-pressure turbine plants has confirmed its advisability. As an example of this application, Fig. 2 shows a plant originally noncondensing which has installed the turbine without governor.

It may at first seem logical, from the viewpoint of steam economy, for the combination engine and turbine unit to be stipulated for new power equipments. The question of ultimate costs must, however,

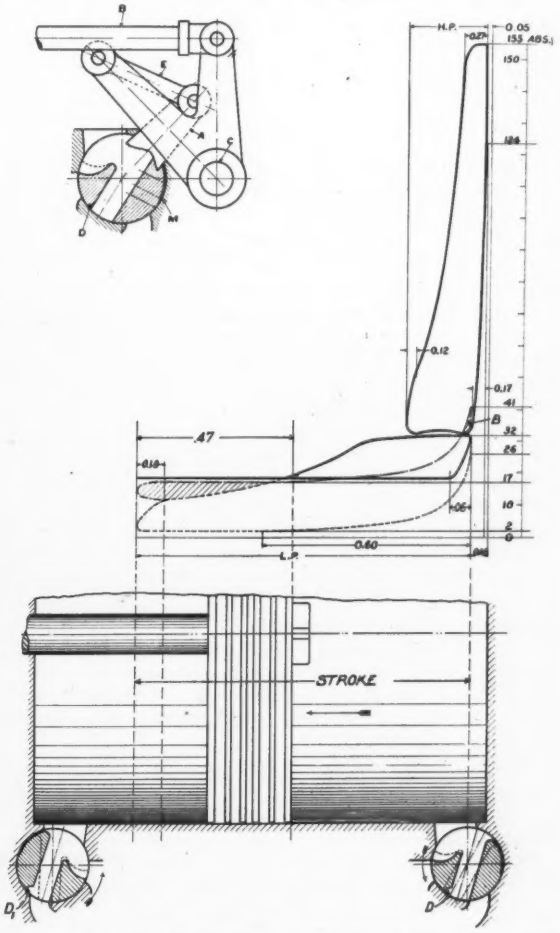


FIG. 3. MODIFICATION OF DIAGRAMS AND VALVE ACTION OF COMPOUND ENGINE WHEN ADDING LOW-PRESSURE TURBINE, D_1 IS FOR EXHAUST VALVE WITH CRANK TURNING OUT, D FOR VALVE WITH CRANK TURNING IN

be considered, and owing to the greater initial, maintenance and operating expenses, we find ourselves obliged to accept the simple turbine, especially for electric generation, and with possible exceptions where favorable disposition of both mechanical and electrical load may exist. .

The preceding discussion relating to constant vs. variable exhaust pressure operation, applies chiefly to the normal condensing cylinder ratio of 4 to 1. For

noncondensing compound cylinders, the mechanical advantage of the latter system more or less vanishes. On the other hand, with cylinder ratios exceeding 4 to 1, looping difficulties assume a serious aspect.

Frequently condensing cylinders have been bushed to obviate trouble with the exhaust valve, more particularly where constant back pressure is maintained. As alteration of the engine invariably entails heavy expense and interruption, it is generally to be avoided. If necessary, low-pressure turbines may be installed for initial pressure of 8 lb. absolute or less. In fact, they could be built to begin expansion from the terminal pressure in a compound engine and carry it out economically to the lowest practicable back pressure. Obviously such a turbine would not be commercially attractive.

In large ratio engines these considerations have induced a study of ways and means to obviate the expense of greatly modifying the engine. It has been found possible to do this by advancing the point of release in the low-pressure cylinder and simultaneously retarding the point of exhaust-valve closure. The result of removing the negative work, both from over expansion and compression, becomes evident in Fig. 3.

Actual drawings and the steam diagram of a 4½ to 1 engine were employed in proving the merits of this scheme. In the combined diagram (upper half of Fig. 3), the heavy lines represent the nature of the indicator card desired. The dotted lines complete the card that would obtain with normal cutoff in the high-pressure cylinder under the conditions for which the engine was originally designed, and the dot and dash lines show the looping that would be encountered with atmospheric back pressure if no changes were made.

When the expansion in the low-pressure cylinder has approximately reached the newly established back pressure (17 lb. abs.), release takes place, and the steam pressure in the cylinder for the remainder of the stroke will correspond to this back pressure.

For accomplishing these results for the engine in question, the simplest means was found by changing the angular position of the valve on the stem, as illustrated in the dotted and full lines. With the original valve setting shown in dotted lines, the exhaust opening does not occur until the piston nears the end of its stroke, but by being advanced to the point shown by the heavy lines, expansion is discontinued and looping avoided.

All that may be required is a new valve stem, on account of the new location of the key seat. Besides, it may be necessary to increase the valve port by chipping off metal at D and D_1, Fig. 3, to prevent cramping of the exhaust on the return stroke. Early release simultaneously accomplishes a delay in the closing of the exhaust valve, so that overcompression, shown in the cross-hatched area is avoided. This particular engine possesses a large amount of lap that simplifies the problem very much. While this method of operating may not prove feasible in all designs of engines, it is practical with the majority.

Use of an Auxiliary Live Steam Admission Valve

WHERE sufficient exhaust steam is constantly available for operating the low-pressure turbine, the simple design, without governor, is preferable. Adequate provision is obviously essential in the power plant to insure continuity of service. With the low-pressure turbine constituting only a small part of the entire generating capacity, the reduction or cessation of its output, due to a deficiency in the exhaust steam supply, may occasion little embarrassment in operation. But when, as frequently found, the addition of the low-pressure turbine doubles the possible output of the original equipment and the actual load is increased correspondingly, then some factor of safety should be introduced.

This is ideally secured by means of a throttling live steam admission valve.

Ordinarily, for plants satisfactorily maintained, the occasion for operating the low-pressure turbine on live steam, is rare, consequently the economy during such periods may be safely neglected. It would not overtax the capacity of the boiler plant, in any event, as it may appear at first, as the turbine would continue to develop power with about the same steam consumption as previously, improving probably 6 per cent from the resulting superheating.

Even with a rapidly fluctuating main engine load, this method proves advantageous. Boilers cannot be regulated quickly enough to provide for sudden decrease on the steam used, and the pressure relieves through the safety valve. Thus the low-pressure turbine equipped with the auxiliary valve, will just absorb the steam otherwise wasted to the atmosphere; hence the controlling of this valve performs a function parallel, in a sense, to the regenerator, and with maximum simplicity. It is plain that no improvement will result from employing an efficient high pressure element in the turbine under these conditions.

Both the main atmospheric and auxiliary live steam valves are of the throttling type. The interposition of a regulating valve between the engine and the turbine does not remove the possibility of variable pressure operation. Adjustment of a counterbalancing spring on the low-pressure turbine governor may be made so that the admission valve in the main exhaust line will remain wide open, unless the turbine should increase in speed a predetermined amount above that of the engine, thus obviating throttling over practically all ranges in load.

(To be continued.)

WATER COLUMNS

By John M. Leitch

WATER columns should be located in horizontal boilers so as to bring the lower end of the gage glass exactly on a level with the top of the tubes, thus always affording a perfect guide as to a depth of water over the tubes. Many gage glasses are placed too low and water tenders and firemen are often deceived by them unless these positions with relation to the tubes are carefully noted.

The only safe plan for an engineer to pursue in taking charge of a steam plant is to seize the first opportunity for noting this relation. When he has washed out his boilers he may leave the top manhole plates out while refilling them, and when the water stands at about 3 in. over the top row of tubes the depth of water in the glass should be measured. This should be done with every horizontal boiler in the plant and a memorandum made for each boiler.

He will then know his bearing with regard to the safe height of water to be carried in the several gage glasses. If he finds any of them are too low he should lose no time in having them altered to conform to the requirements of safety. The position of the lower gage cock should be 3 in. above the top row of tubes.

DE LAVAL TURBINES FOR LOW-PRESSURE STEAM

THE use of exhaust steam or other low-pressure steam for producing power in steam turbines opens up engineering possibilities of remarkable promise. As may be seen by consulting a steam table, the difference in temperature between steam at ordinary boiler pressures, as 150 or 175 lb. gage, and steam at atmospheric pressure, is approximately equal to the difference in temperature between steam at atmospheric pressure and steam under a 28-in. vacuum. That is, the temperature of saturated steam at 150 lb. gage is 366 deg. F., which gives a range of 154 deg. F. when expanding to atmospheric conditions, while steam expanding from atmosphere to 28-in. vacuum has a working range of 114 deg. F. It therefore follows from well known thermodynamic laws concerning the maximum efficiency possible for a heat motor, that the percentage of heat that can be converted into work between 2 sets of limits are approximately equal.

When expansion ratios are taken into consideration the same relations appear. For instance, when steam expands adiabatically from 150 lb. gage to atmosphere, the volume increases about 8.3 times, while in expanding from atmosphere to 28-in. vacuum, the volume increases about 11.65 times. These ratios do not hold exactly for steam expanding in a cylinder, on account of condensation and re-evaporation, but the agreement is close enough for the purpose of the present illustration.

Each 3 deg. F. added to the temperature range at the condenser end increases the power obtainable from a pound of steam by about one per cent. In expanding from a 28-in. vacuum to a 29-in. vacuum (referred to 30-in. barometer), the volume is approximately doubled.

As already stated, the reciprocating engine is not adapted to expand steam to extremely low pressures, but the turbine can do this to good advantage.

Now, it is one of the peculiarities of steam turbines, of no matter what type, that the nozzles and passages in which expansion of the steam takes place can be designed for efficient operation at only one ratio of expansion. In the case of the compound reaction turbine, this means that the number of rows of blades and the pressure drop per stage must be proportioned to the range of pressure with which the turbine is intended to operate. If it is desired to operate with 2 ranges of pressure, 2 ratios of expansion must be provided for. This is generally done by arranging to admit the low-pressure steam at an intermediate stage, allowing it to expand through the long blades of large area at the low-pressure end of the turbine, while when high-pressure steam is used, it is introduced at the high-pressure end of the turbine and is allowed to expand through the entire series of blades.

With this arrangement, however, the high-pressure end of the turbine runs idly in the steam during the periods when no high pressure steam is being used and thereby wastes a considerable amount of power. Moreover, a mixed flow turbine of this type is practically as costly and complicated as a high-pressure turbine, whereas otherwise the low-pressure turbine should cost much less, due to the fewer rows of blades required for the expansion of low-pressure steam.

The expedient of reducing the pressure of live steam through a reducing valve for use in a low-pressure turbine is not profitable if the live steam must be supplied for any length of time. It might even be better in such cases to have 2 turbines, one for the live steam and one for the exhaust steam.

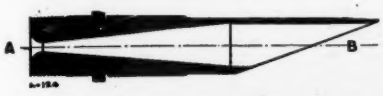


FIG. 1. DE LAVAL NOZZLE FOR HIGH PRESSURE CONDENSING SERVICE

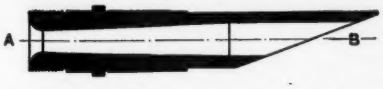


FIG. 2. DE LAVAL NOZZLE FOR LOW PRESSURE OR HIGH PRESSURE NON-CONDENSING SERVICE

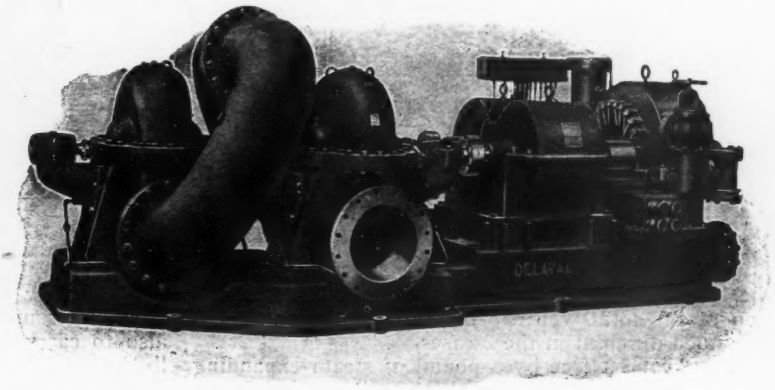


FIG. 3. DE LAVAL TURBINE PUMP UNIT

Difficulties in connection with using 2 steam pressures are avoided in the type of steam turbine illustrated herewith, viz., the single-stage impulse turbine, or De Laval Turbine, as it is more generally known. In this turbine the complete expansion of the steam takes place in a single nozzle. Steam entering at full pressure expands in the nozzle to the final or condenser pressure, thus converting the heat energy available between the 2 temperature limits into energy of velocity. In correctly designed nozzles the efficiency of this conversion may exceed 95 per cent.

A nozzle designed for receiving high-pressure steam and exhausting into a condenser is shown in Fig. 1, while a nozzle for receiving exhaust steam and discharging into a condenser, or for that matter, for receiving live steam and discharging against atmospheric pressure, which involves about the same expansion ratio, is shown in Fig. 2. The power that can be delivered by one of these nozzles is surprising. For instance, a nozzle of which the minimum diameter of throat opening is 0.5 in. will develop 75 hp. when receiving steam at 125 lb. pressure and exhausting into a 27-in. vacuum. It is thus possible, by

utilizing the full periphery of the wheel to place a sufficient number of nozzles for various ratios of expansion to suit a variety of conditions. For instance, one set of nozzles can be provided to receive high-pressure steam and exhaust to a condenser and one set to receive low-pressure steam and exhaust to condenser, the latter being also available for use with high-pressure steam exhausting to atmosphere, since that involves about the same ratio of expansion.

It might appear that a mixed flow turbine of this type would be a compromise, that is, that the efficiency when operating on either high or low pressure would be sacrificed, since the velocity of steam issuing from the nozzle would be different in the 2 cases, while the velocity of the wheel must remain the same. Considering, however, that $V_1^2 \div 2g$ is the energy of a pound of steam before it strikes the blades, where V_1 is the nozzle velocity of the steam and g the acceleration of gravity, and that $V_2^2 \div 2g$ is the energy of a pound of steam leaving the blades, where V_2 is

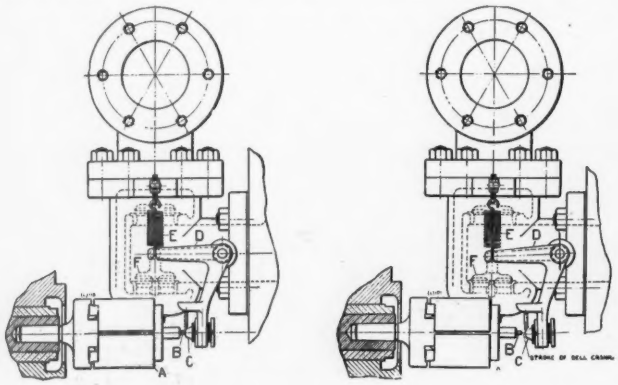


FIG. 4. OPEN AND CLOSED POSITIONS OF DE LAVAL GOVERNOR AND VALVE

the leaving velocity, it will be seen that the proportion of the total work abstracted from the steam is not much different in the 2 cases.

The heat set free by a pound of steam expanding from 150 lb. gage to 2 lb. absolute is 225,620 ft. lb. corresponding to a steam velocity of 3,710 ft. per second. If the periphery of the wheel runs at 1,500 ft. per second and the angle of entrance and exit of the steam is 20 deg., the velocity of the steam leaving the bucket will be 1,330 ft. per second. The proportion of the total energy converted into useful work will therefore be 81 per cent.

Now, taking the case of steam at 15 lb. absolute expanded to 2 lb. absolute, the available work is 101,900 ft. lb., which gives a steam jet velocity of 2,480 ft. per second. Taking the same rim velocity and angles as before, this gives an absolute velocity of the steam leaving the buckets of 846 ft. per second and the conversion into work of 88.7 per cent of the energy originally in the steam. The above comparison is based upon unit efficiency of nozzles and blades and in actuality the figures are reduced somewhat by eddy and friction losses, but the relative values remain substantially the same.

We thus see that a wheel speed suitable for one ratio of expansion will serve fairly well for all other ratios encountered in high or low-pressure work by modifying the nozzles in order to obtain the best conditions.

A machine in which all these possibilties have been utilized is shown in Fig. 3. This turbine, which generates 150 hp. for 2 16-in. centrifugal pumps, connected in series, was installed in a large steel mill to receive the exhaust from a number of hydraulic pressure pumps and other auxiliary machines, all exhausting into a common header. Because of the feasibility of using live steam in a separate set of nozzles to supplement any deficiency in power from the exhaust steam, it was not considered necessary or advisable to install a regenerator or other means for storing heat, nor was a reducing valve fitted to supply steam at low-pressure from the boiler. The turbine exhausts into a large central condensing plant, which also serves a number of rolling mill engines, and in which the vacuum varies from 18 to 27 in. of mercury, averaging about 22 in. There is also a possibility of losing this vacuum entirely at times, due to troubles with the engines or to air leaks, making it necessary to operate the turbine non-condensing. The requirements of the specifications, which were fully met under test, were as follows:

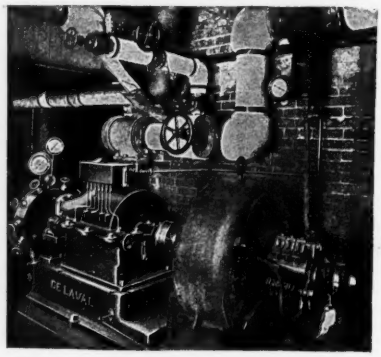


FIG. 5. LOW-PRESSURE TURBINE DRIVING A 35 KW. ELECTRIC GENERATOR

"To carry full load when using steam at atmospheric pressure exhausting into a vacuum of 22 in., also to carry full load when receiving steam at 120 lb., and exhausting into a vacuum of 22 in., also to operate condensing with steam at 90 lb. pressure. exhausting into a vacuum of 22 in., and in an emergency to operate noncondensing with steam at 90 lb. pressure, all changes to be carried out automatically by the turbine itself, with the exception of the change to the noncondensing condition."

The turbine is fitted with 2 governor valves and 2 governors, one for high-pressure steam and one for low-pressure steam, the high-pressure governor being set at a few revolutions below normal speed and above the speed keeping the high-pressure valve tightly closed. The low-pressure governor is set for normal speed, but on the failure of the low-pressure, steam supply, the machine will drop a few revolutions, less than 2 per cent, whereupon high-pressure steam is admitted to the high-pressure nozzles.

At the same time the low-pressure nozzles continue to utilize any exhaust steam available, the pressure limits varying in practice from 2 lb. above atmosphere to 5 in. of vacuum.

To provide against runaways, as in case the high-pressure valve should leak when the turbine was lightly loaded, an emergency stop is provided, consisting of a butterfly valve in the exhaust pipe controlled by a piston but normally held open by a spring. In case of excessive speed, air is admitted behind the piston, closing the butterfly valve. As soon as the

speed is normal again, the governor closes the air valve and the air leaks into the vacuum, the butterfly valve in the exhaust pipe again restoring normal conditions. As will be seen, this involves no interruption of the condenser service, as does the usual vacuum-breaking device.

This machine drives a De Laval centrifugal pump raising 5,000 gal. of water per minute against a total head of 65 ft. to a purification plant during part of the time and supplying 4,000 gal. of water per minute under a head of 95 ft. to the service mains during the remainder of the time.

For Ice Making

AN interesting application of low-pressure turbines is illustrated in Fig. 5. This little machine is installed in an ice plant, receiving the exhaust steam from the ammonia compressors and driving a 35 kw. Crocker-Wheeler direct-current generator supplying current for lighting and for the operation of 2 elevators, a machine shop and a coal elevator. The turbine develops 30 kw. with steam at atmospheric pressure when exhausting into a vacuum of 25 in., the steam consumption not exceeding 45 lb. per brake horsepower hour.

Poor vacuum obtainable in this case is explained by the fact that the circulating water used in the condenser serving the turbine has already been warmed to a certain degree by passing over the ammonia condensers. When receiving steam at 95 lb. pressure, and exhausting into a 25-in. vacuum the unit is able to develop 35 kw. with a steam consumption of 28 lb. per electrical horsepower hour. When running noncondensing, the steam consumption is 43 lb. per brake horsepower-hour. Incidently the exhaust from this turbine, after condensation, is used for icemaking, the absence of oil rendering it perfectly suitable for such purposes. The only item of running cost in this case is the small amount of oil required by the turbine bearing and gears.

The auxiliary power required for the condensing plant of an exhaust turbine is small, the current consumed by the electric-driven auxiliaries amounting to not more than 3 per cent of the current developed by the turbine itself. Due to the possibility of shutting off nozzles as the load decreases, the above type of turbine has a flat efficiency curve, giving remarkably good performance even at quarter-load. This efficiency is retained indefinitely, as there is no leakage past valves or piston rings due to wear.

ABSORPTION ICE MACHINES

By Wm. Kavanagh

IN THE ABSORPTION SYSTEM, aqua ammonia is used which is distilled water saturated with pure ammonia, the water being capable of absorbing 700 times its volume of the ammonia gas when its temperature is about 50 deg. F. This aqua ammonia is pumped into a vessel called a generator, where it is heated either by exhaust or live steam passing through coils situated in the generator, and the gas thus evolved from the aqua ammonia is the gas that is employed to do work by absorbing heat, the gas being first condensed to a liquid in the condenser.

Let us consider one complete journey or cycle of the gas formed in the generator. The gas rising from the surface of the aqua in the generator passes up through a vessel called the analyzer, from there it goes to a vessel called the rectifier, from the rectifier it goes to the condenser where it is liquefied as in the compression system, from the condenser the liquid is led to a vessel called the cooler into which it is admitted through an expansion valve. The cooler is fitted with a coil through which circulates a brine.

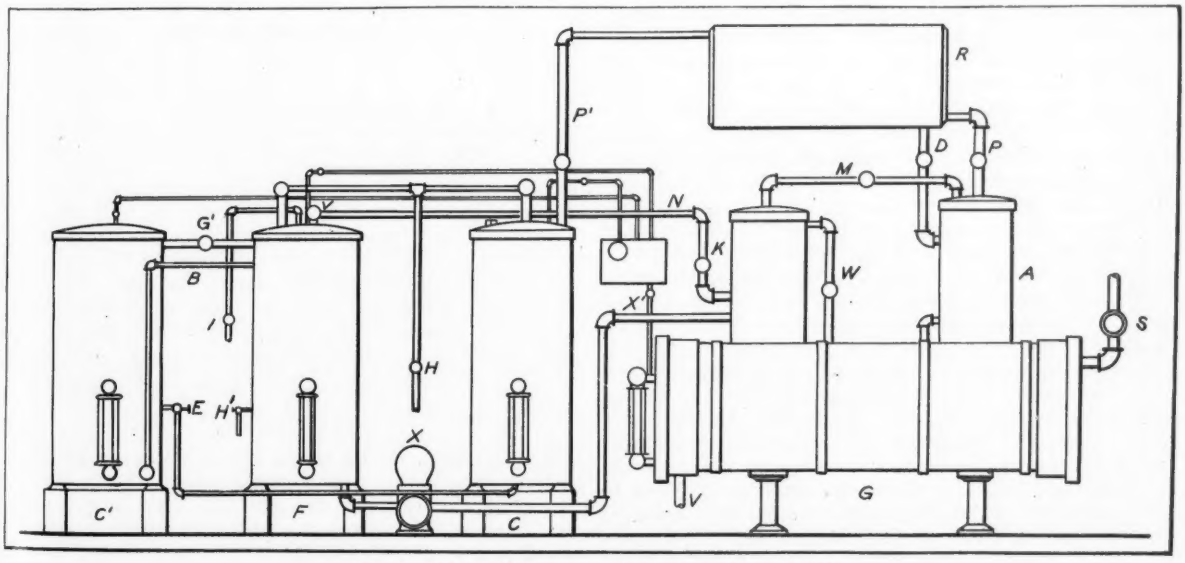


FIG. 1. GENERAL PLAN OF ABSORPTION PLANT

The ammonia entering the cooler is now evaporated into a gas by reason of its low boiling point, and this evaporation robs the brine in the coils of its heat and the gas rises up around and outside of the brine coils

and leaves the cooler through a valve called the gas valve and enters a vessel called the absorber.

Figure 1 illustrates the general plan of an absorption plant and while the arrangement shown here may not be followed out in some places, still the vessels used and general principles are the same. The generator is shown at G, in which are placed steam coils. Aqua ammonia being in this vessel, steam is admitted to the coils through the valve S. Ammonia gas will now be generated and it will ascend to the analyzer, A, from there the gas will flow into the

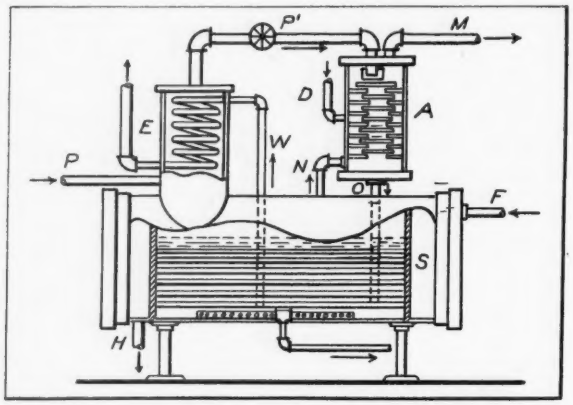


FIG. 2. CROSS-SECTION OF GENERATOR, ANALYZER AND EXCHANGER

rectifier R through the pipe, P, from the rectifier the gas will go to the condenser C through the pipe, P', from the condenser the gas which is now in a liquid flows to the expansion valve E situated on the cooler, C'.

The liquid ammonia being admitted to the cooler through valve E is now evaporated into a gas and issues through valve G' into the absorber, F. Now when the ammonia gas is distilled from the aqua ammonia in the generator it leaves the remaining liquor, called "poor liquor," which is not rich with ammonia.

The weak or poor liquor pipe, W, extends inside the generator to within a few inches of its bottom, and when pressure is exerted on the surface of the liquor in the generator, due to vaporization of the ammonia, the weak liquor is forced up through pipe W and into the exchanger, K, it traverses the exchanger and flows out through the pipe N and enters the absorber through the spray valve, V, situated on top of the absorber.

We are now in a position to understand there are flowing into the absorber a gas from the cooler and a weak liquor from the generator, here the weak liquor is sprayed over the incoming gas from the cooler and absorbs the gas, thus becoming what is called a "rich liquor." This liquor will now fall over the cooling coils and rests on the bottom of the absorber. The liquor is now a "rich liquor" and it is taken by the rich liquor pump, X, and discharged through the pipe X' into the exchanger, K. The rich liquor will now traverse the exchanger and enter the analyzer through the pipe, M. From the analyzer it goes to the generator to be evaporated again and traverse the path which has just been described.

Cycle of Cooling Water

FIRST the cooling water enters the condenser, it then flows through the cooling coils of the absorber, from there it flows through the cooling coils of the rectifier where it issues to waste or storage or cooling tower. In the illustration the water pipes are not shown in order to make clear the ammonia piping.

The Exchanger

IN Fig. 2 the exchanger is shown at E. The rich liquor enters through pipe P, and circulates around the outside of the coil as shown and flows to the analyzer shown at A through connection P'. The poor liquor rises up through pipe W and flows through the coil on its way to the absorber. The rich liquor on its way to the generator absorbs heat from the poor liquor on its way to the absorber and thus an exchange of heat is effected, the rich liquor increasing in temperature while the poor liquor loses its heat, increasing its affinity for the ammonia gas issuing from the cooler, this is the function of the exchanger.

The Absorber

THIS is shown in Fig. 3, the gas enters the absorber through pipe, P, from the cooler, and the poor liquor enters it through the spray valve, V. The gas pipe P, reaches the center of the absorber and then turns downwards. The poor liquor will absorb the

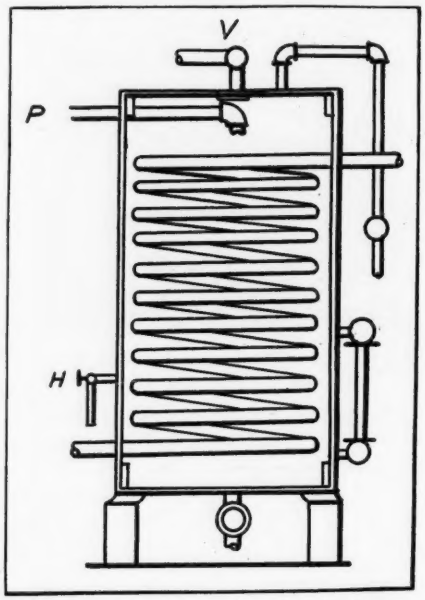


FIG. 3. INTERIOR VIEW OF ABSORBER

gas as it issues from P and falls to the bottom of the absorber where the rich liquor pump takes it and discharges it into the exchanger as mentioned before.

The absorber is fitted with 2 or more spiral coils through which the cooling water circulates. It is also fitted with a top and bottom purge valve, gage glass, and some absorbers are also fitted with a float which automatically controls the speed of the rich liquor pump and prevents it from racing or becoming gas bound.

The Analyzer

IN this vessel, shown at A, Fig. 2, pans are arranged over which the rich liquor trickles on its way to the generator through the pipe O. This pipe extends well below the surface of the liquor in the generator as shown by the dotted lines. The gas rising from the generator passes into the analyzer through the pipe, N, and rises up through the pans and carries off with it any gas given up by the rich liquor entering from the exchanger. The gas now ascends to the rectifier through pipe M. The rich liquor entering the

analyzer falls into a pan, over which it flows on to the next pan, the object of this being to prevent splashing, as far as possible.

The Rectifier

THE purpose of the rectifier is to dry out the gas that enters it from the analyzer. It is constructed like a condenser of the double tube-type, the gas entering the lower outside tube and rising upward through the coils on its way to the condenser. The cooling water enters the top of the inside tube and circulates downward and out at the bottom, where it runs to waste or cooling tower.

The rectifier is sometimes placed on the roof and each of the gas coils are dripped to a common header, the drippings entering the analyzer through the pipe D, as shown in Figs. 1 and 2. The critical point to be noticed about the rectifier is not to cool the gas so as to liquify it. Should this occur it would fall back to the generator to be re-evaporated and in this case the generator would be doing work and accomplishing very little. There is a bypass on the water circulating pipe which permits a nicety of regulation by graduating the amount of water, and in this way the gas can be dried or freed of any water moisture without liquifying the gas and at the same time throwing down all water held in suspension by the gas. The water issuing from the rectifying coils should feel warm to the hand.

The boiling point of a liquid depends on the pressure impressed on its surface, thus the boiling point of water under atmospheric pressure is 212 deg. F., while the boiling point of ammonia at the same pressure is —29 deg. Now, as the heat in the generator increases, a rapid distillation of the ammonia gas occurs which carries with it some moisture from the water. This moisture cannot be allowed to go over into the condenser. It is eliminated in the rectifier

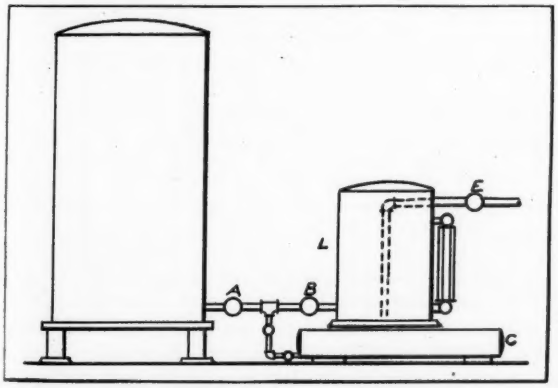


FIG. 4. CONDENSER WITH AMMONIA RECEIVER

and the moisture finds its way back to the generator through pipe D shown in Figs. 1 and 2.

From the above, it will be seen that the elimination of the water vapor from the ammonia gas is a very important function in the absorption system of refrigeration. Sometimes the drying out of the gas is called dehydration.

The Generator

FIGURE 2 shows an interior view of one form of generator and it resembles a surface condenser. The steam enters the steam space S through the pipe F and then passes through the tubes and out through the pipe H. This pipe is connected to a trap which discharges the condensation to waste or storage tank. Owing to the pressure carried on the generator it is now being made of steel, the pressure varying from 120 to 180 lb. per sq. in. Some manufacturers use cast iron, but this metal is liable to crack from unequal expansion in starting up the plant and it is not reliable under tension.

A very important detail in the method of circulating the weak liquor is the perforated pipe lying near the bottom. The pipe is capped at both ends, which insures a better distribution of the weak liquor on its way to the absorber. The generator is fitted with a pressure gage, thermometer and safety valve.

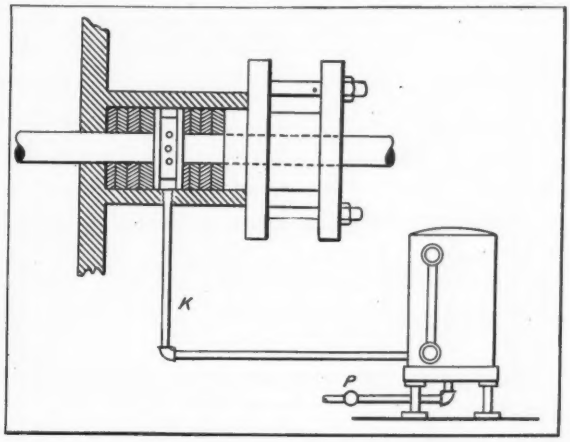


FIG. 5. STUFFING BOX DETAIL ON RICH LIQUOR PUMP

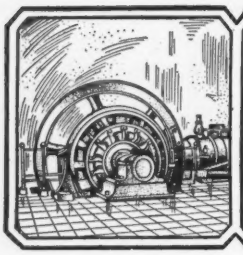
The Condenser

AT C, Fig. 1, is shown the condenser, which is fitted with a safety valve, gage glass and purge pipe. When the anhydrous gas is liquified it rises in the glass, showing its level or amount of liquid ammonia in the condenser. Some condensers are fitted with a liquid ammonia receiver as shown in Fig. 4 at L. It is fitted with a gage glass which shows the height of the liquid ammonia, the ammonia being led from this receiver to the various expansion valves through the valve E.

Figure 5 shows the construction of the stuffing box of the rich liquor pump. Any leakage past the perforated thimble is led into a small liquid receiver as shown. This receiver is fitted with a gage glass which indicates the amount of rich liquor leaking past the thimble. The rapidity with which the liquor rises in the glass is a warning that the packing needs attention. The receiver is connected to the suction of the rich liquor pump through the pipe P. When all of the liquor can be pulled out of the receiver, it is obvious the pipe K could be connected to the suction of the pump, but there would be no means of telling the amount of the leakage.

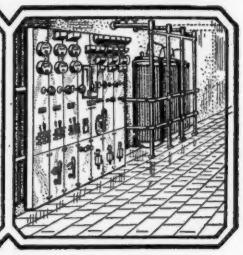
(To be continued.)

DENSE VEGETABLE GROWTH of the Nile, which is a continual nuisance to river navigation, may become an Egyptian asset, if the tests made of it as fuel in the form of briquets are as successful as claimed. The vegetable growth, known as sudd, is to be dried, disintegrated and compressed into briquets by machinery. The resulting fuel is claimed to be suitable for use in boilers, in which it is expected to give an evaporation of about 4.75 lb. of water per pound of briquets.—Popular Mechanics.



Electrical Machinery

For Generating, Transmitting and Using Current



PLANNING A WIRE SYSTEM

THE following problem has arisen in the layout of the system for lighting a small town. Location of streets and street lights, also of business houses to be lighted, is as indicated on Fig. 1, the map being drawn to the scale of 400 ft. to the inch.

The Load

THE load is 145 lights for indoor lighting, half of these being 40-watt and the other half 25-watt incandescents. About half of each size will be used in each building.

Number of lights on each tap is shown on Fig. 1, and each tap is 150 ft. from the street line to the house connection box. Eleven street lights are to be supplied at points indicated by the dots, each light of 60 watts capacity. How shall the wiring system be run and what sizes of wire will be needed?

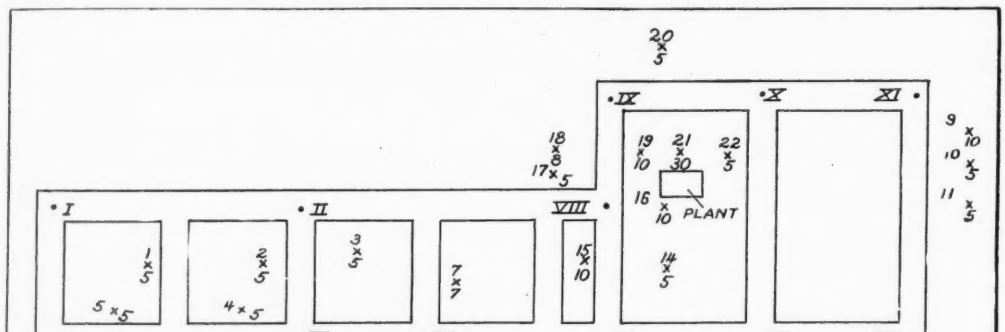


FIG. 1. LAYOUT OF LIGHTS TO BE FURNISHED

Data as given do not specify voltage to be supplied, nor do they state how the wiring shall be arranged. The distances are rather long for a 110-volt system, but it is possible that such a system might be used, and it will be easy to proportion from that to a 220-volt if the working out for 110 volts shows that design to be undesirable.

Wire for 110 Volts

STARTING, therefore, on the assumption first that it will be a 110-volt system: As it is desirable to be able to cut off the street lighting circuit during the moonlight hours, while the house circuit must be left on at all times, provision must be made either for running 2 entirely separate circuits or for running a positive wire common for both circuits and a separate negative return wire for each system in order that separate switches may be used. In either case the computation for circuits would be made separately and the single outgoing wire then made equal to the size of one wire from each of the circuits.

Turning to the April issue data sheet you will find there a table for quick computation of sizes of wire. To use this we have to multiply the number of amperes transmitted in a circuit by the number of feet single distance. To determine the number of amperes which will have to flow in any circuit, we divide the watts to be furnished by that circuit by the number of volts. This gives us, then, as our rule for getting ampere feet, which is the number necessary in order to use the table; watts divided by voltage and multiplied by single distance of transmission equals ampere feet.

For the part of the street circuit marked A, Fig. 4, we have at the end a single 60-watt light. Therefore, divide 60 by 110, and multiplying by the distance, which is 666 ft., we get 363 as the ampere feet.

In order to work quickly it is easier to use the slide rule in connection with these computations In this case, using the lower scales of the rule, over 60 on D we would set 11 on C. Bring the runner to 1 on C and bring 10 on C to the runner. Then carry the runner to 666 on C, which will be a trifle to the right of 66.5 and under the runner on D will be found 363, remembering that each of the small divisions between 36 and 37 counts as 2 units, so that 1.5 of these divisions is equal to 3 units.

Drop Allowable

LOOKING now in the table of wire sizes for electric circuits we have to determine what voltage we can allow to lose on this section of the wiring. If we study the layout of the system it is seen that from the plant to the end of the circuit of which A is a part, there will be a number of sections. If we are running at 110 volts we must keep the drop between the lamp nearest the station and that farthest from the station a reasonable amount so that the far lamps will not be too dim and the near lamps will not burn out too rapidly. A difference of 6 to 8 volts is the most that is allowable under these conditions and that would make it permissible in our computations to use 1 volt drop on each section.

Looking, then, along the line for 1 actual volt lost, which is the top line in the table, we find that the nearest figure to 363 ampere feet is 315, and running down this column to the bottom index row of figures, this is No. 12 wire.

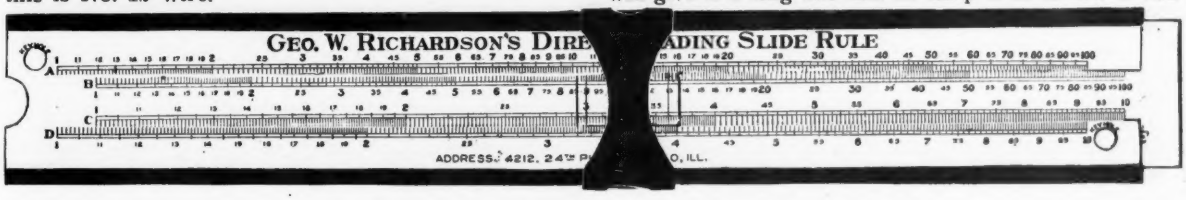


FIG. 2. SLIDE RULE SETTING FOR FIGURING AMPERE FEET IN B

Going now to the part of the circuit marked B, we have to carry through this the current for stations I and II or 120 watts and to get our ampere feet we divide 120 by 110 and multiply by the length of section B of the circuit, which is 300 ft.

If we perform this on the slide rule, over 12 on D we set 11 on C, bring the runner to 3 on C and under this on D we find 327. Going now to the table on the 1 volt loss line we find, by the same process as outlined before, that it again calls for a No. 12 wire.

Continuing this method we find that for the section C of the street circuit there are 3 lamps to be supplied. We divide, therefore, 180 by 110 and multiply by 366, the length of the section C, and performing this computation either by figures or on the slide rule we get 598 as the ampere feet, which is intermediate between No. 10 and No. 8 wire. We simply make a memorandum of No. 10 and No. 8 with an interrogation point and go on with the rest of the computation because the final decision will tell us what size of wire goes onto this section.

Now for section D we have 4 60-watt lamps and the ampere feet will be found by dividing 240 by 110 and multiplying by 549, the length of the D section, giving us 1198 ampere feet; and this at 1 volt drop would call for No. 6 wire. For the section E, which is at the other end of the street, we have 1 light with transmission distance of 500 feet. 60 ÷ 110 and multiplied by 500 gives us 273 ampere feet, which from the table would give us No. 12 wire as the nearest available size. Actually, it would show intermediate between No. 14 and 12, but No. 14 is too weak mechanically for outdoor construction.

For section F we have 2 lights to be supplied, and 120 ÷ 110 and multiplied by 400 gives us 436 ampere feet, which call for No. 10 wire. For section G we have to carry all the lights on the 2 circuits so far figured, and also the light at V. This gives us 420 watts and the length of section G is 366 feet. We have, therefore, 420 ÷ 110 and multiplied by 366 which gives us 1400 ampere feet, calling for intermediate between No. 6 and No. 5 wire. For the section H there is 1 light added, giving us 480 watts, and the length is 160 feet. We have 480 ÷ 110 and multiplied by 160, gives 698 ampere feet, which would call for No. 8 wire.

Going to the upper street circuit we find that the section farthest from the station is a duplicate of that on E circuit, so that we can likewise label this E, also, the F circuit is the same. J circuit carries 3 60-watt lamps and the transmission distance 250 ft., so that we have 180 ÷ 110 and multiplied by 250, giving 409 ampere feet, which calls for No. 10 wire.

Deciding the Wire Size

NOW, looking at the different wires called for, we have some No. 10, some No. 8, some No. 12 and some No. 5. It is not material that the lamp at any particular point should burn at any particular voltage so long as no lamp is above the voltage which will give it a long life and no lamp is at so low a voltage as to burn dim. It is, therefore, not of consequence whether there is exactly one volt drop on each section of circuit or not, so long as the difference in voltage between the lights nearest the station and those farthest from the station is not too great. It becomes a matter of using one's judgment to see if one size of wire may be adopted which will do for the entire street lighting circuit and still keep the drop at a reasonable amount. From study of the different sizes called for, No. 10 seems to be the one probably best suited for the purpose.

It is, then, necessary to see, taking No. 10 wire, what the voltage drop will be on each section, which we can do quickly by using the wire size table. In the No. 10 column we find that for section A, having 363 ampere feet, the drop would be approximately ¾ volt. This can be estimated nearly enough from the ratio of the ampere feet needed to the ampere feet at any given drop, as our computations do not require great refinement.

For the section B, calling for 327 ampere feet with No. 10 wire, we should also have ¾ volt drop. For the section C, calling for 598 ampere feet, we would get about 1.2 volts drop. On section D, calling for 1198 ampere feet, we would get 2.3 volts drop. On section E we would get about ½ volt, on section F, about 1 volt, on section G, about 3 volts, on section H, 1.5 volts, on section J, ¾ volt.

Taking now the sections of circuit that are in series, adding together the drops on H, G, D, C, B and A, the total drop from the plant to light I would be 9¾ volts, but 1.5 volts of this takes place on the section H between the station and light VIII, so that the difference in voltage between VIII and I would be 8¼ volts, which is a permissible amount. This circuit might do very well.

House Lighting System

TURNING now to the house lighting circuit, we find at the far end at Station 1, 5 lights. It evidently will not be worth our while to split up the circuit

into different sections between each house, so that we will assume that the wire will be the same size over to the second street corner, that is, to the corner where III street light is located. There will be on this line 4 houses of 5 lights on each house, and the average distance of transmission works out to 475 feet.

The question comes, How is this determined? The method is to multiply each number of lights by its distance from the end of the circuit nearest the station, add these products together and divide by the total number of lights. This gives the average distance. The problem states that about half the lights are 40 and half 25-watt. Assuming that we have 3 40-watt and 2 25-watt in each house burning on the average will give 170 watts at each station, and in the absence of more definite information this may be accepted as a fair value. Four houses would then give 680 watts and dividing this by 110 and multiplying by the single transmission distance, 475, gives 2930 ampere feet.

On the slide rule we get this by setting 11 on C over 68 on D and as 475 is now off the scale, we set the runner at 1 on C and bring 10 to the runner, then carry the runner to 475 on C and under this on D we get a reading, 293, which by inspection is found to be 2930. Allowing, as before, 1 volt drop in the section, we find that this would call for a No. 2 wire.

Taking the section of the house circuit marked b, which runs on another street, we find only 1 house connected. Distance of transmission here is 566 ft. and the watts 170. We have, therefore, 170 ÷ 110 and multiplied by 566, which gives 876 ampere feet and at 1 volt allowed drop this gives No. 8 wire. Figuring for one of the taps we find that allowing ½ volt drop in this type brings us out with a smaller size than No. 14, but as No. 14 is the smallest allowable wire for lighting, that would be used for the taps from the street mains to the house connection on all the residences.

Taking now section c of the circuit and assuming that we would use the same size wire all the way between points V and III, we find that there are 7 5-light connections and 1 7-light connection to be supplied, which amounts to 8.4 5-light connections. We should, therefore, have 170, the number of watts on a 5-light connection, multiplied by 8.4 and divided by 110. We find that the average transmission distance is 782 feet, so that we should have to multiply our quotient by 782.

To work this on the slide rule, at 17 on D we set 11 on C. This throws both 84 and 782 off the scale. We see, therefore, that it will be better to make a multiplication first, so we set 10 on C to 84 on D, bring the runner to 17 on C. This would give us 170 multiplied by 84. We then bring 11 on C to the runner, which gives us the division by 110, and look for 782 on C. This is off the scale and we must, therefore, set runner to 1 on C, bring 10 on C back to the runner and then carry the runner to 782, and we find under the runner on D the reading 1015, which by inspection is found to be 10,150. Looking in the wire table under 1 volt drop we find that this would call for No. 0000 wire.

Taking the right-hand end of the lower street as a single circuit, which carries up the far street on the right-hand side, we figure our connected load as equivalent to 6 5-light houses and the average distance as 1096 ft. We have then 170 × 6 ÷ 110 multiplied by 1096, which gives us again 10,150 as near as we can read. This would also be No. 0000 wire.

Taking the section g, we have to carry all the lights previously figured on, as well as the equivalent of 6 additional 5-light stations. This is 20.4 5-light stations to be carried all together. We therefore multiply 170 by 20.4, divide by 110 and multiply by the average transmission distance, 266, giving as ampere feet 11,550, which is nearest to No. 0000 wire.

Taking the j circuit, we have the equivalent of 11.6 5-light stations and an average transmission distance of 340 feet, so that 170 × 11.6 ÷ 110 and multiplied by 340 gives us 6100 ampere feet, which would call for No. 00 wire on the j circuit.

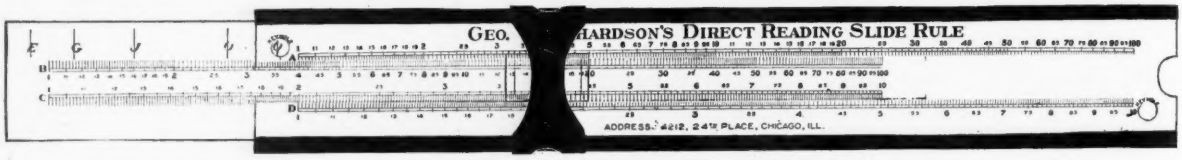


FIG. 3. SLIDE RULE SET FOR DIVIDING QUANTITIES BY 2

Choosing a Single Wire Size

LOOKING over the different sizes called for, No. 00 seems to be the best suited for a single size of wire for these circuits. Taking the 00 column in the wiring table, we find that the drop on the section a, 2930 ampere feet, would be about 0.4 volt. On b it would hardly be noticeable, in fact, we would probably not run 00 wire from b, as this is a special circuit and might as well be carried of No. 8, the size called for. On section c, 10,150 ampere feet would be 1.7 volts drop; on f it would be the same, on g it would be 1.9 and on j it would be 1 volt. The greatest drop would then be g + c + a, or 4 volts. It is evident that we could use a smaller wire than No. 00 safely, and in view of the high cost of copper wire it is worth trying No. 2 to see where the drop would fall.

If we use No. 2 wire, the drop on section a will be 0.9 volt; that on c, 3.2; that on g, 3.6; or total of 7.7, which would be a permissible amount.

This would be all right and this is the greatest drop that there would be in the system, but the cost of No. 2 wire for the lengths of circuit involved would be heavy and it is best to figure it out on the basis of a 220-volt system.

Figuring for 220 Volts

WE can find our ampere feet readily from the previous computations, because with a 220-volt system we shall have the same number of feet, the same number of watts, but double the voltage, therefore half the number of amperes at a given point, and the ampere feet will, therefore, be half the amount for a 110-volt system. In the case of the part A of the street lighting circuit, we would then have 363 ÷ 2.

As we have to divide all the ampere feet values previously found by 2, there is opportunity to do a new kind of figuring with the slide rule which is interesting. If we place 2 on scale C over 363 on scale D, we shall find under 1 on scale D the value 1815 on scale D, which would be the number of ampere feet. This process has been the same as sub-

tracting from the value for 363 on the D scale the value for 2 on C scale. If we, therefore, pull the slide to the left until 2 on C stands over 1 on D our 1815 on D is below 363 on C. In other words, if we set the divisor on scale C at 1 on D, we shall then find under the dividend on C the quotient on D. This is a method that applies where a number of values are to be divided by the same figure.

Continuing we find that for the section B of the street circuit the ampere feet for 110 volts was 327. Dividing this by 2, which we do by leaving the slide at its setting and carrying the runner to the point 327 on C scale, we find underneath this 163 on the D scale. For the section C we have 598 ampere feet at 110 volts, which gives 299 at 220 volts.

For the section D we have 1198 ampere feet at 110 volts, and on our slide rule this now extends to the left of scale D. We shall, therefore, have to reverse the slide and bring 2 on C to 10 on D, then under 1198 on C we shall find 599 on D. Continuing this same process we find for the section E, 136 ampere feet, for the section C, 218, for G 700, for H 349, and for J 204.

It is easier to keep on with this figuring for the house lighting circuits, while we are at it. We find that for the section a, house lighting circuit the ampere feet for 110 volts is 2930, and divided by 2 gives 1465. For the section b it gives 876 ampere feet at 110 and at 220 gives 438. For c at 220 volts it is 5075, and for f 5075, for g 5775, for j 3050.

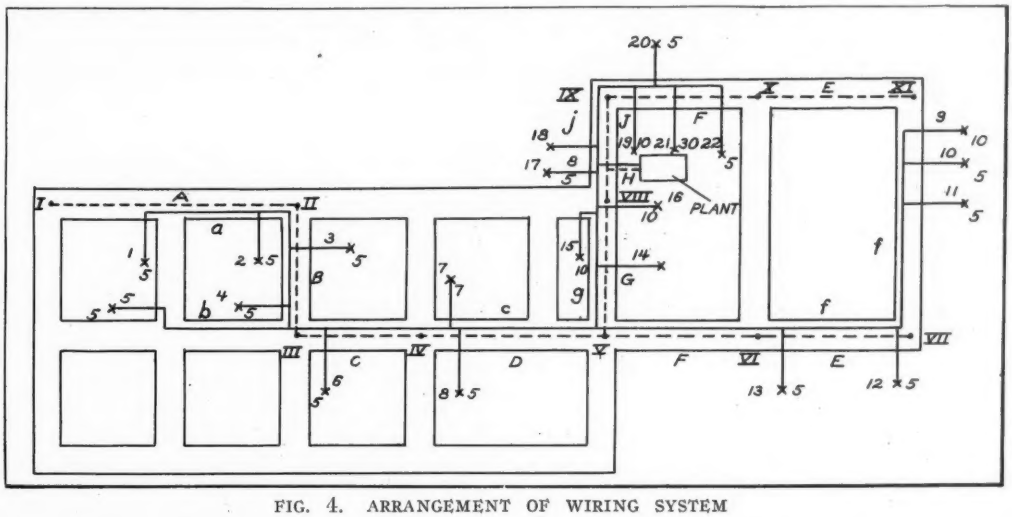


FIG. 4. ARRANGEMENT OF WIRING SYSTEM

Drop Allowable

WE can afford to allow 20 volts as our maximum drop over the lines with a 220 volt system running our generators at 240 or thereabouts and having 220 volts on the farthest lamps. On this basis our heaviest drop, as we found for the 110-volt circuits, will be on the house lighting line made up of sections g plus c plus a.

We might assume that it would be possible to allow on each of these a drop of 6 volts. Going to our wiring table we find that for a, this would require No. 12 wire, for c a little larger than No. 8, and for g larger than No. 8, but if we use No. 8 through the circuit the total drop from the station to the end of a will not be more than the amount permissible.

Running through the other circuits, we now see that if we use No. 8 wire on a it will give us about 1.8 volts drop, on b about 0.5, on c 6.2, on f 6.2, on g 7.5, on j 3.8. The maximum drop would then be 1.8 volts on a, plus 6.2 on c, plus 7.5 on g, or 15.5 volts total, which is entirely permissible.

On the street lighting circuit we find that using No. 14 wire we would get 0.7 volt drop on section A; 0.6 volt on B; 1.5 volts on C; 3 volts on D; 0.5 volt on E; 1.2 volts on F; 3.5 volts on G; 2 volts on H; and 1.1 volts on J, estimating these values from the "actual volts lost" column and the ampere feet as already figured out. Evidently the voltage drop on the street lighting circuit at 220 volts would be entirely permissible with a No. 14 wire.

The only difficulty in the arrangement of the 220-volt system is the fact that in some of the houses

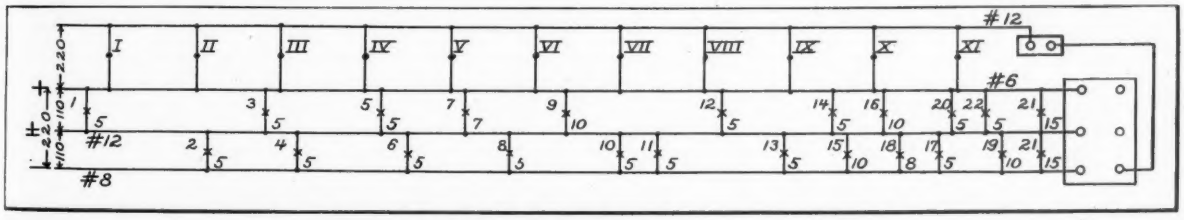


FIG. 5. METHOD OF CONNECTING LIGHTS TO MAINS

25-watt lamps are used while a 25-watt lamp is not made for 220 volts. If it is necessary, therefore, that 25-watt lamps be supplied, the only method would be to run a 220-volt 3-wire system and take the 25-watt lamps between the outside and the neutral. The 40-watt lamp at 220 volts would not be very satisfactory on account of the long filament and it would probably be better, so long as the 110-volt system must be used part of the way, to run the whole house lighting system on 220 volts 3-wire. In this way the advantage

of 220-volt transmission can be secured while being still able to use the 110-volt lamps.

Three main wires will do for both circuits, street lighting and house lighting. The positive wire would be made large enough to carry both the street lighting and the house lighting loads, in other words, it will be about the area of a No. 8 and No. 14 combined, which from the table of properties of copper wire in the data sheet for April would be figured as follows:

The area in circular mils for No. 8 is 16,510; for No. 14 is 4,106; the combined area would be 20,616, which is something less than a No. 6 wire.

As the No. 14 wire for the other side of the street lighting circuit would be mechanically weak, for outdoor work, it will probably be better to use No. 12 wire for the negative side of the street lighting circuit, and use No. 8 for negative wire on the house lighting system and No. 6 for the common wire. The difference in cost of circuit from using a little larger wire than is absolutely necessary would be but slight and will allow for increase in load as well as giving greater mechanical strength.

For the neutral wire on the house lighting system we should then want, according to the common practice for 3-wire systems, an area about ½ that of the negative house-system wire, which would fall between No. 12 and No. 10. A No. 12 wire would probably do in this case, as the arrangement is such that the load can be very evenly balanced.

Current Capacity

IT is always wise, after having reached a conclusion in regard to the size of wire, to be sure that no wire is loaded above its proper ampere capacity. The wire which will have to carry the heaviest load will for both street lighting and house lighting circuits be on the section h nearest to the station. For the house lighting this figures out at 15.8 amperes and the safe current capacity is 46 amperes on No. 8 wire. For the section H on the street lighting system, where the current will be 2.16 amperes, the safe current capacity of No. 12 wire is 23 amperes, so that both circuits are well above any possible current requirement.

The street lights are, of course, 220-volt 60-watt tungstens at all stations and the lights are connected between the negative street wire and the common positive wire. The house load would be divided as follows: 5 lights at 1 would be connected between the common positive and the neutral; 2, between the house negative circuit and the neutral; 3, between positive and neutral; 4, between negative and neutral; 5, positive to neutral; 6, negative to neutral; 7, positive to neutral; 8, negative to neutral; 9, positive to neutral; 10, negative to neutral; 11, negative to neutral; 12, positive to neutral; 13, negative to neutral; 14, positive to neutral; 15, negative to neutral; 16, positive to neutral; 17, negative to neutral; 18, negative to neutral; 19, negative to neutral; 20, positive to neutral; 21, 15 lights on each side of the neutral; 22, positive to neutral.

The generators would naturally be specially wound for the 220-volt 3-wire system, with balancing coils, thus doing away with a balancer set or storage battery equipment.

WIRE ROPE FOR HOISTING AND TRANSMISSION

RECENT CHANGES IN THE tables for standard strengths of wire rope have made it desirable that the strength of such rope and the net loads proper for it to carry when used for hoisting and for power transmission should be recomputed. The tables of strength as given by the manufacturers present some irregularities, but as this is probably due to the different ratio of diameter of wire to diameter of rope necessary, these irregularities have been preserved in the final results.

There is no difference in the load which a rope can lift when bent over a sheave or on a straight pull because in the bending, wires on one side are put in compression and those on the other side in tension so that the pull due to the load increases the tension on one side and reduces the compression on the other side of the rope.

Bending back and forth of the rope does, however, wear the wires and also stresses them so that not only will the area be reduced from the wear, but also the repeated bending will fatigue the metal. Rope used for hoisting is not flexed as rapidly and continuously as is rope used for transmission and may, therefore, be worked over a smaller pulley.

Two Styles Used

FOR hoisting and transmission purposes one of 2 kinds of rope is usually used, the bright strand wire, having 6 strands with 7 wires to each strand, and that with 6 strands having 19 wires to each strand, the latter being more commonly used for hoisting in running ropes and rigging, and the former for transmission. The reason for this is that for hoisting it is desirable to use as small a pulley as possible, which makes the greater number of smaller size wires, giving greater flexibility, the more convenient rope to use.

This rope wears more rapidly, however, where it is frequently bent and unbent, because of the smaller diameter of the wires and the greater number of wires to rub on each other. For that reason the 6 strand 7 wire rope is usually used for transmission. Here the large pulleys necessary can be arranged for easily and the greater life of the rope more than makes up for the less flexibility.

Either of 2 styles of lay may be used, the regular or the "lang lay." In the lang lay the wires in each strand are twisted in the same direction as the strand is twisted in the rope, so that they bed close together. In the regular lay, the wires in the strand are twisted opposite to the twists of the strand of the rope, so that the tendency of the strands is to twist together instead of apart. In the lang lay, since there is less twist of the wires in strand, this reverse twist to hold the rope compact is not essential.

The 7 wire strand usually has the wires about 1/3 the diameter of the strand and the 19 wire strand has the wires 1/5 the diameter of the strand. This works out that for the 6 by 7 rope the diameter of the wire is 0.1111 times the diameter of the rope and for the 6 by 19 rope the wire diameter is 0.0667 times the diameter of the rope.

Internal Stresses

WALTER C. KRETZ, mechanical engineer of the John A. Roebling's Sons Co., has given, in the Engineering Digest, a careful mathematical analysis of the internal stresses in wire rope due to load and the twist of the wires in the strand; he finds that for 7 wire bright strand rope the lay of the wire in the strand is 25 times the diameter of the wire, while for 19 wire the lay of the wire in the strand is 35 times the diameter of the wire. The length of lay of the strand in the rope is for 7 wire rope strand 7 times the diameter of the rope and for 19 wire strand 6 times the diameter of the rope.

Without going into the mathematical analysis of the stresses on each wire due to the pull on the rope and the angle of the wire with the axis of the rope, it is found that taking the area of a solid bar of the same diameter as the rope as unity, and its strength as 100 per cent, for the 7 wire strand when used alone the metallic area is 0.778 and the strength is 76.4 per cent that of the solid bar. For the 6 by 7 rope with wire center, the metallic area is 0.605 that of the bar and the strength 56.8 per cent; for the 6 by 19 rope with wire center the area 0.592 and the strength 53.9 per cent. The 2 by 7 rope with hemp center has metallic area 0.518 and the strength 48.4 per cent, and the 6 by 19 rope with hemp center has metallic area 0.507 and strength 45.8 per cent. The rope with hemp center is the one usually used for hoisting and transmission.

Values as given above are theoretical figures and do not correspond to actual results obtained on the testing machine because wire sizes usually differ somewhat from those previously assumed; also the wires where they rub against each other will nick a little bit and it is found that this nicking greatly reduces the strength of the wire.

Allowable Load

IN order that the life of rope may be good, the working load is taken at 2/3 the elastic limit of the wire in the rope. Mr. Kretz takes as the elastic limit for steel 65 per cent of the ultimate strength and for iron 75 per cent of the ultimate strength, so that the total pull which a rope can carry may be taken as 2/3 times 0.65, or 0.44, the ultimate load for steel; and 2/3 times 0.75 or 0.5, the ultimate load for iron.

Bending Stress

FROM this total load which may be carried by the rope must be subtracted the tension due to bending stress. This tension has been worked out from Reuleaux's formula and depends upon the coefficient of elasticity and the ratio of diameter of wire to the pitch diameter of the sheave about which the rope bends. The bending stress by this formula in somewhat different form has been worked out by the engineers of the Trenton Iron Works and is given in Kent's Mechanical Engineer's Pocket-Book. From values of those tables the accompanying curves in the data sheet supplement have been plotted.

It is obvious that since this bending stress depends only on the modulus of elasticity which is found to be practically the same for either steel or iron wire as used in ropes and upon the ratio of diameter of wire to diameter of sheave, the bending stress will be the same for a 6 by 7 rope, whether that be made of steel or of iron, so that the same bending stress curves can be used, no matter what the material of the rope may be.

The values for ultimate strength of rope have been taken from the standard tables of strengths published by the American Steel & Wire Co., the sizes considered being those usually used for hoisting and transmission work, 1⅜-in. diameter down to ⅜-in. diameter. For these the diameters, trade numbers, and approximate weights per foot are as given in the following table:

Diam. in Inches.	Trade No.	Weight per Foot, Pounds.
1⅜	5½	3
1¼	6	2.45
1⅛	7	2
1	8	1.58
⅞	9	1.20
¾	10	.89
⅝	10¼	.62
9/16	10½	.50
½	10¾	.39
7/16	10a	.3
⅜	10b	.22

Horsepower Transmitted

TABLES as given in the data sheet supplement show for iron and for crucible cast steel the breaking load, the minimum diameter of sheave permissible for continuous transmission use, the net allowable

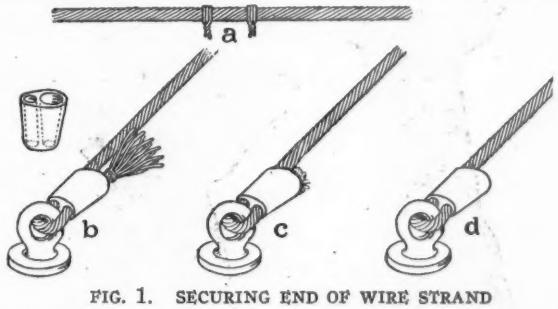


FIG. 1. SECURING END OF WIRE STRAND

load or pull on the rope, and the horsepower at 100 r.p.m. of the sheave given. Of course, a different size sheave may be used and may be run at a different speed than 100 r.p.m., but in case the sheave as given in the tables is run at some other speed, the

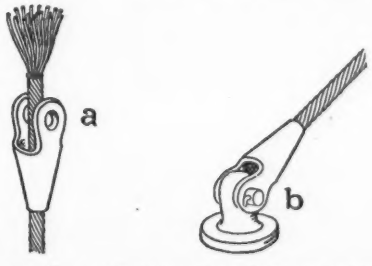


FIG. 2. SECURING ROPE END IN SOCKET

horsepower transmissible would be found by dividing the actual speed in revolutions per minute by 100 and multiplying the quotient by the horsepower as given in the tables.

In case of using any other diameter of sheave than that shown in the tables, the bending load should be found from the proper curves for the size rope and diameter of sheave that are to be used, and this load substracted from the allowable pull for that size rope; this will give the permissible tension on the rope due to load or power transmission.

For power transmission the difference in tension between the 2 sides is taken as half the permissible net tension and this difference in tension is to be multiplied by the circumference in feet of the sheave chosen and divided by 330. This will give the horsepower at 100 r.p.m., and for any other speed we would divide the speed in revolutions per minute by 100 and multiply the horsepower at 100 r.p.m. by that.

Net Load Curves

IN order to simplify this computation and also to be able to determine quickly the load that any size rope can carry on any sheave, curves have been plotted for the different sizes of rope, the axes being the diameter of sheave and the permissible load in pounds. If, for instance, we wished to use a 6 by 19 iron wire rope 1 in. in diameter on a 5 ft. sheave,

FIG. 3. SHORT BEND AND PROPERLY USED THIMBLE

we should go to the curves for that kind of rope and starting at the point labeled "5 ft." on the scale of diameter of sheaves, pass vertically upward to the curve for 1 in. diameter rope. We would then follow horizontally to the left to the scale of net working loads and find this would be about 2300 lb. That would be the amount which could be lifted when using the rope for hoisting.

If we wished to find the horsepower that this rope would carry, we would take half this value, or 1150 lb., as the difference in tension between the tight and loose sides of the rope; then figure the circumference of a 5-ft. wheel, which we should find to be 15.7 ft., and divide this by 330. We find that this gives 55 horsepower transmissible by this rope on a 5 ft. sheave at 100 r.p.m. If we compare this with the table, we find that on a 7-ft. sheave the same rope would transmit 190 horsepower at 100 revolutions, the allowable pull being 5750 as being compared with 2300 on the 5-ft. sheave. By the same process the allowable load and the horsepower which can be transmitted may be found for any other kind or size of iron or cast steel rope for any diameter of sheave. The curves and tables are all found in the data sheet supplement.

Making Fast the End

IN connection with the use of wire rope, interesting material was published in the American Wire Rope News for February on connections as used for construction of aeroplanes, but the same methods and same precautions apply to the use of larger rope for other purposes. Certain of the methods are suitable only for the smaller work such as method of securing a strand of ropes to small eyes, which is done by taking a double wrap of the wire through the eye, laying the end of the wire alongside the standing part and wrapping the 2 together with a ferrule of tin, which is then soldered and the ends of the wire bent back over the ferrule.

Another method is the short snug twist of the end around the standing part, the whole being soldered together. Still another method is one which may well be used for fastening the end of any rope into a socket or through an eye. It is shown in Fig. 1, and would be suitable for use only with a single strand rope as with more than 1 strand there would be too much tendency for the strands to slip on each other and a proper wedging action could not be secured.

The 3 steps in the process are so clearly shown that description is not necessary except to say that

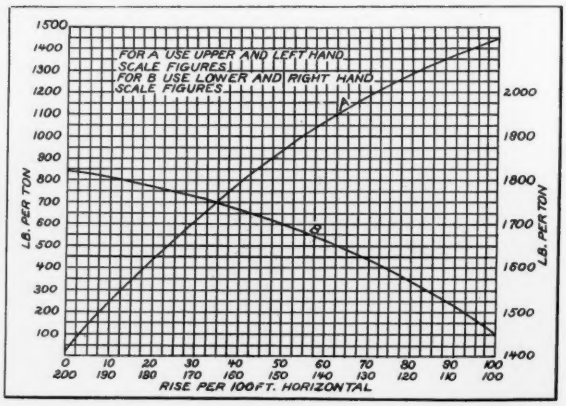

FOR A USE UPPER AND LEFT HAND SCALE FIGURES
FOR B USE LOWER AND RIGHT HAND SCALE FIGURES
LB. PER TON
LB. PER TON
RISE PER 100 FT. HORIZONTAL

FIG. 4. STRAIN ON HOISTING ROPE USED ON AN INCLINE

after position C is reached the ends of the wires are spread apart and melted solder run in to form the wedge. The method of using this form of fastening for a socket is shown in Fig. 2. This can well be used, either for a single strand or for a rope, as the ends of the strands can be spread apart above the binding wire and the solder run in to make a solid mass.

One objection should be made to the methods shown in Fig. 1, viz., the rope is bent short over the eye. This is not of so much importance in the single strand provided the material of the eye is of large diameter and particularly if it is to be a fast joint which has no motion, but where the wire will bend short about a comparatively small iron, as in rigging or in guy ropes, the thimble should always be used. The effect of the short bend and of the use of the thimble are shown in Fig. 3 and it will easily be seen that the spreading apart of the strands and the sharp bending of the wires will cause rapid wear

of the rope at that point if the short bend is made. The spreading of the strands brings the strain all on the inside strands, those on the outside pushing apart until they take but little tension.

Rope on an Incline

WHEN hoisting ropes are used on an incline, the pull on the rope is, of course, not equal to the weight drawn up the incline, varying with the angle of rise. The rate of increase of this pull per ton is rapid at first and afterwards slower and slower, as shown on the curves, Fig. 4.

This curve will determine, after the allowable pull on any rope has been taken from the tables and the data sheets, the number of tons that can be drawn up any given incline by that rope. If we wish to use a 6 by 19 cast steel rope ½ in. diameter on a rise of 100 in 100, from the table for 6 by 19 cast steel rope we find that the allowable pull on ½-in. rope is 7400 lb. Going to the curve we find that for a rise of 100 ft. in 100 it takes 1450 lb. pull for each ton drawn up; then 7400, the total pull permissible, divided by 1450 gives 5.1 tons as the load which can properly be drawn up the incline under these conditions.

For hoisting alone, the minimum diameters of sheaves given in the tables of the rope manufacturers for the 6 by 7 and 6 by 19 iron rope in the larger sizes, is less than those given herewith, but it is believed that for transmission purposes the longer life due to the greater radius of bend will more than pay for the slight extra cost of the larger sheaves.

RECENT PROGRESS IN EUROPEAN AIR NAVIGATION*

By W. A. Blonck

AIR NAVIGATION EXCITES at present the warmest interest of the entire civilized world, because it means the abandoning of one of our oldest traditions, namely, that we are chained to the surface of this globe. From the beginning of time, as indicated by the mythological story of Daedalus and Icarus, men have wanted to fly, but not until the 20th century, through the fast development of the gasoline engine, was the beginning in the conquest of the air made possible.

At the present time there are 2 types of air ships partly developed, namely the heavier than air machines, or aeroplanes, as constructed by the Wright Bros., Curtis, etc., in the United States, and the lighter than air machines or dirigible balloons built by private corporations in Europe for the military authorities of the various countries and also for passenger traffic and advertising service in commercial enterprises.

FIG. 1. W. A. BLONCK

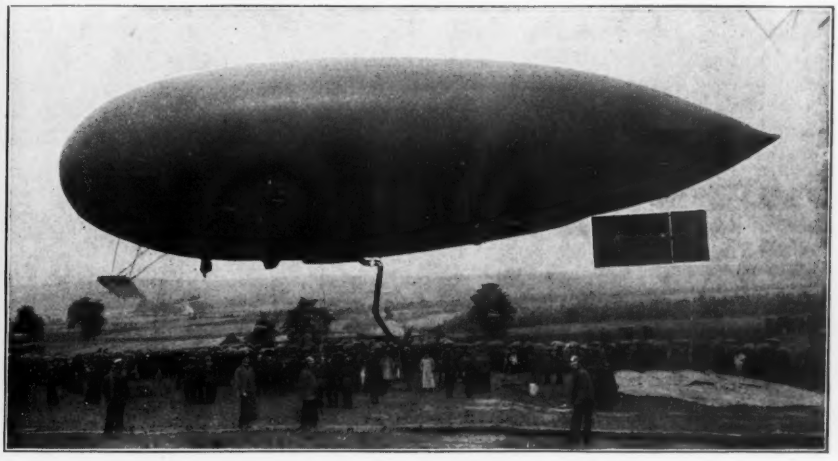


FIG. 2. A PARSEVAL READY FOR ASCENT

Types of Balloons

CONSTRUCTION of dirigible balloons in Europe and particularly in Germany has advanced very far and there are at present 3 distinct groups in operation: 1, the rigid type or Zeppelin; 2, the semi-rigid type or Gross; 3, non-rigid type or Parseval.

The body of the Zeppelin ship forms a rigid skeleton of very light aluminum girder construction and contains a multiplicity of small balloons or ballonets filled with hydrogene gas, the latter to give the craft sufficient buoyancy just to raise it from the ground. The maneuvering in the vertical and horizontal planes is done dynamically by means of 2 sets of rudders and the thrust of the motor propellers. The actual operation of these ships has not proven very successful without elaborate harbor facilities.

The semi-rigid type, first constructed by Lebaudy Freres in France, consists of a rigid keel with a horizontal rudder attachment, from which a large simple gas bag and car are suspended. This type is used largely in the French and German armies; with sufficient engine capacity in the larger sizes speeds up to 40 miles an hour in calm weather have been obtained.

The non-rigid or Parseval type consists of a large gas bag made of double-ply cotton fabric with diagonal threads and a thick intermediate layer of India rub-

*Address before the Internal Combustion Engineers' Association.

ber. This fabric reaches the highest possible degree of impermeability. It is strong enough to withstand a strain of 1000 lb. per running foot and affords an effective margin of safety against any pressures to which it may possibly be subjected. The gas bag is kept taut by a front and rear ballonet filled with air under a pressure not to exceed 1 in. water column. These air ballonets are collapsible compartments inside the gas bag and have a suitable hose connection with a ventilator in the car.

In addition to the 2 interior ballonets, the hull comprises the following parts: The main valve for emptying the gas, the double air valve with the feed pipe for the ballonets, 2 horizontal stability planes in the rear, a vertical stability-fin to which is affixed the vertical rudder, and finally the suspension-belt to which the suspension cordage is attached. A rip cord which allows instant release of the hydrogen is attached to the top of the gas bag to be used in case of forced landing on account of gales or storms.

The design of the car and its suspension system has been constantly altered and improvement secured in each vessel; details of some of the latter types will be given further on. The great advantage of the nonrigid type of dirigible is that it can be carried readily in a wagon, making transportation in case of accident or storms an easy matter.

Vertical steering, in the large Parseval dirigibles, is effected by feeding the air from the ventilator either into the rear or forward ballonet alone, or simultaneously into both. If the forward ballonet is filled to a greater extent than the rear one, the dirigible descends, owing to the fact that the bulk of the gas is driven to the rear of the envelope; the ascent is effected in the opposite manner.

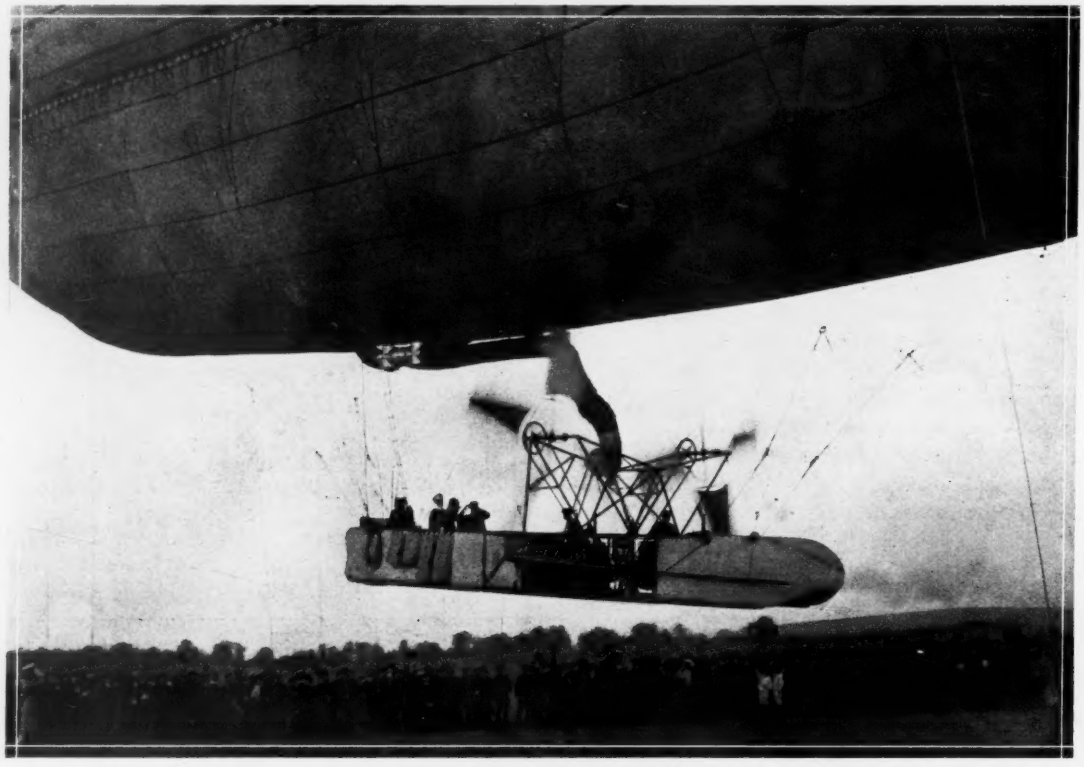


FIG. 3. LARGE PASSENGER CAR ASCENDING

Gas Bag and Propelling Machinery

DURING the large number of ascents and by numerous laboratory tests it was discovered that the head resistance of the vessel is actually of less importance than the friction of the air along the sides of the hull. By analogy with marine ships, the lines of the hull were so designed as to offer the minimum of resistance, by allowing the air to flow away regularly towards the rear. The shape, therefore, of the more recent type of Parseval dirigible has become that with the hull tapering toward the rear and ending in a fairly sharp point.

Construction of the new car, too, has required the greatest care, having regard to the powerful motors it contained; built of steel throughout, it is in addition reinforced in every direction in order to withstand the thrust of the twin propellers, situated one on either side. Fig. 4 shows the arrangement of car and method of suspension.

The driving mechanism of the B type dirigible was so designed that either motor by itself can drive both propellers, both motors working in conjunction can drive both propellers, or again either motor can drive one propeller. Since there are 2 couplings, it is quite easy to uncouple the motors, consequently one of the motors only need be started and the other motor can then be thrown into gear.

This dirigible was equipped with 2 100-hp. 6-cylinder motors, provided with 3 carbureters. With this arrangement it is possible to stop any single pair of cylinders, while the others continue working, in order to make adjustments or repairs while the motor is running during an ascent. Another notable feature of these 6-cylinder motors is the absence of vibration

while they are running, a point which considerably adds to the comfort of the passenger in the car.

The propellers of the most recent types are of the semi-rigid construction which possess the advantage of greater reliability while all danger of damage through possible contact with the rigid driving mechanism, as in the case of wholly limp propeller, is avoided. Furthermore, disasters such as have occurred in France and also with German dirigibles with the rigid type propellers, due to the propeller blade breaking off in flight, piercing the envelope and sending the vessel to the ground, are impossible with these semirigid screws. It has also been thoroughly demonstrated by recent laboratory tests that the semi-rigid propeller used with the Parseval dirigibles are actually more efficient than even the best specimens of rigid wood propellers.

In the spring of 1910, there was designed a new G type, a vessel of 197,700 cu. ft. capacity, which was equipped with 2 150-hp. motors placed one behind the other, and designed to develop a speed of 38 miles per hour.

The Runabout Type of Dirigible

WHAT is known as the sporting dirigible, completed early in 1910, was designed with the idea of producing a vessel of the smallest possible dimensions, but capable of carrying from 3 to 4 persons, and attaining a speed of 20 miles an hour or more. The design provided for a run of from 5 to 6 hr. In its principal dimensions the vessel measures 128 ft. in length, 25¼ ft. in diameter, and has a volume of 47,650 cu. ft. By constructing the envelope from strips of fabric running lengthwise, the resistance due to surface friction has been greatly reduced.

In one detail this differs radically from every other Parseval dirigible in that vertical steering is effected, not by 2 ballonets, but by a horizontal rudder affixed near the bows of the hull and controlled from the car by cables passing over a steering-wheel. Through this arrangement the vessel is so sensitive to control that it can be navigated with perfect ease at a height of but a few feet from the ground. The interior pressure of the gas, and consequently the rigidity of the hull, is maintained by a central ballonet fed with air by a centrifugal ventilator. In order to guard against the pressure being increased unduly, an automatic valve, opening at a water column pressure of 0.59 in., is fitted between the ventilator and the ballonet.

The balloon itself is also provided with a valve, the latter, however, only opens at a pressure of 1 in. water column. This balloon has made many notable trips and is often hired by societies and clubs for the use of their members, either by the week or by the month.

Engines Used

THERE is no question but that the internal combustion engine, like any other, is liable to break down and this is the case not only with motor-car or motor-boat engines, but more particularly with the much lighter aerial engines which, in spite of constant improvement, have not yet reached that degree of absolute reliability possessed by the stationary steam engine. Bearing this difficulty in mind, the latest design of this type of dirigibles has been provided with 2 motors, each developing 30 to 35 hp. and jointly driving a single propeller. In this way it becomes possible either to drive ahead under full power with both motors running, or else extend the possible radius of action by running either motor alternately.

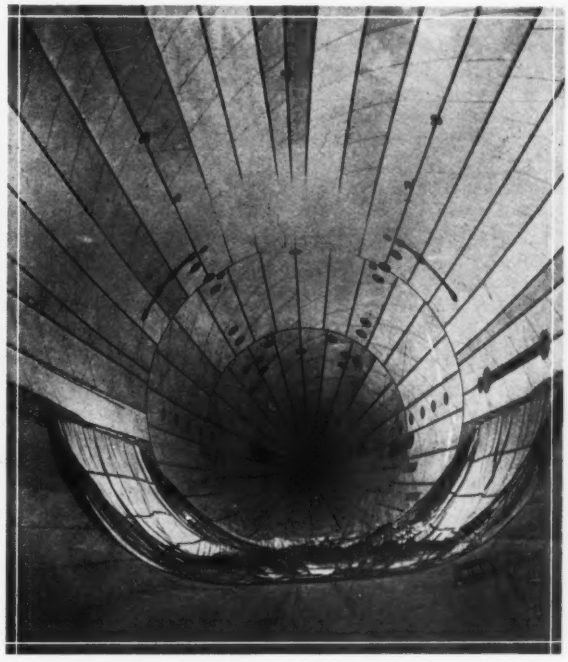


FIG. 5. INTERIOR VIEW OF A PARSEVAL

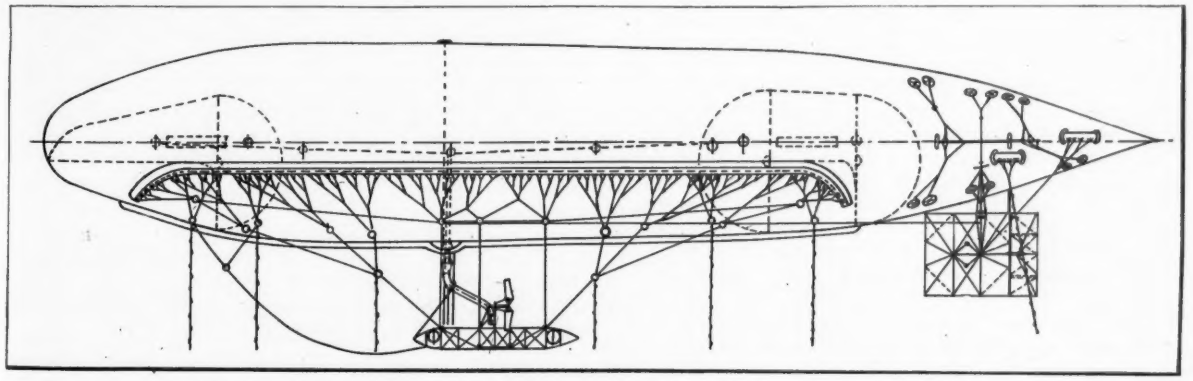


FIG. 4. OUTLINE OF G. TYPE VESSEL SHOWING METHOD OF SUSPENDING CAR

Reversible Propeller

ALTHOUGH for the present a dirigible, soaring high above the earth, stands in no urgent need of being capable of rearward motion, nevertheless facility of control is greatly increased by the possibility of running one propeller forward while reversing the other. This means of control has been made possible by the invention of a semirigid propeller which is so designed as to possess a variable pitch. This renders the employment of 2 motors feasible since the pitch of the propeller is reduced when only one motor is in action. These variable pitch propellers have been generally adopted, and possess the remarkable advantage of being reversible.

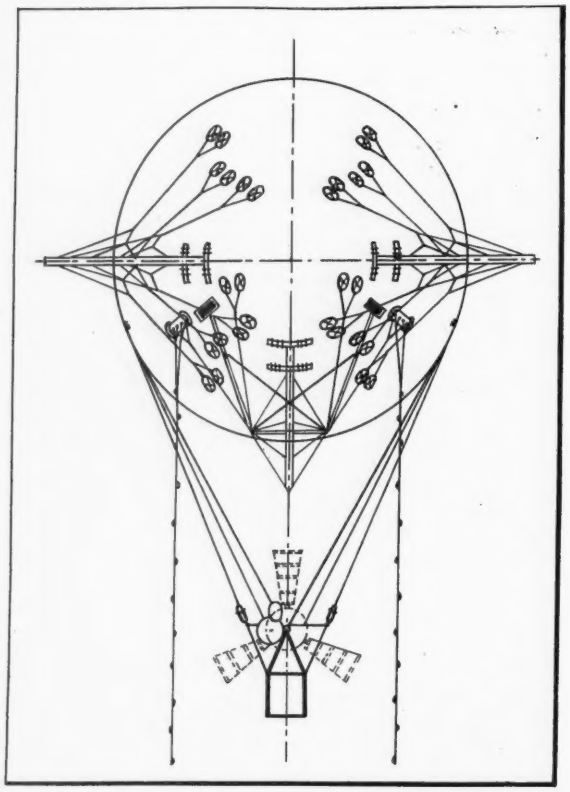


FIG. 6. REAR VIEW OF SPORTING DIRIGIBLE

This type of propeller is also of great advantage in landing since it allows a dirigible to land in a restricted space by reversing the propeller.

An important feature in the design of recent types of dirigibles is the suspension of the car. The main suspension cables form a constant vertical parallelogram and maintain the car in a position parallel to the longitudinal axis of the balloon. In addition the car is suspended from inclined cables running to the bow and stern of the envelope and passing over 4 pulleys attached to the car. This arrangement prevents the dirigible from tilting upwards under the thrust of the propeller which is applied to the car. In consequence the propeller works just as favorably as if the thrust were applied to the center of resistance of the airship.

Air Ship Stations

THE German Government has gone into the problem of air navigation very extensively and has made many provisions for taking care of its ships and securing safety to those who operate them. Among the noteworthy provisions is that of depots placed at various points along routes over which ships are apt to be taken. These are necessarily quite large structures and in order to facilitate housing the ship, the depots are placed on large turntables. These depots are supplied with all necessary machinery and conveniences for repairing ships as well as with gas tanks for filling the envelopes. Aside from the permanent depots, the government has provided emergency stations where portable gas tanks are placed which may be used for filling the gas bags in case of accident along the route.

There is provided also a number of observation stations made of iron frames and glass. At these stations, the conditions which effect flight, such as temperature, density of air and air currents, are ascertained and sent by wireless telegraphy to the ships.

The other condition which affects the flight of the ship is the loss in weight of the car, due principally to using up the gasoline in the engine and also the temperature of the gas in the ship. These conditions must of course be ascertained upon the ship itself. A plan has been suggested for condensing the exhaust, thus maintaining a constant weight as regards fuel supply.

One method used to find the pull of the air and the direction of counter currents is by raising a kite of known dimensions and measuring the pull upon the string. At the surface of the earth the method employed for determining the strength or pull of the wind is by attaching a hydrogen-filled ball to a rod hung to a pole, the direction of the wind is thus indicated and the strength can be calculated from the angle which the supporting rod makes with the vertical pole.

In Germany the art of air navigation has been made a science and at one of the large universities a testing laboratory has been equipped to investigate the friction of ships of different design at different speeds of air current. From this they are able to ascertain the size engine to supply with a certain kind of bag. These laboratories are equipped so that the entire mechanics of air navigation can be investigated and the design of the ship for commercial use brought down to a certainty.

The dimensions and capacities of the largest Parseval, known as Type B, are: Volume, 236,603 cu. ft.; length, 229.6 ft.; master diameter, 40.3 ft.; span, including tail planes, 58.4 ft.; total height, 65.6 ft.; length of car, 32.8 ft.; width of car, 4.6 ft.; height of car, 3.9 ft; 2 motors of 110 hp. each; weight of envelope with cordage, 4889 lb.; weight of car with motors, 6908 lb.; speed, 31 to 34 miles per hr.; length of flight, 20 hr. and over; altitude attainable, 8,200 ft.; crew and passengers total, 12 to 16; crew, 3 or 4.

The development in practical air transportation is well under way and the distinct grouping of the service in accordance with distances to be traveled is already perceivable; using familiar names the grouping for the service will be as follows:

1. Suburban service, consisting of sight-seeing parties, excursion trips to near pleasure resorts and advertising displays from dusk to midnight.
2. Interurban service, consisting of passenger traffic between 2 large cities separated by a small body of water (Paris-London; Hamburg-Copenhagen, etc.).
3. Long distance service, consisting of trans-Atlantic and trans-Pacific passenger traffic.

Among the transportation companies working under the first group the one in Munich showed the following results for a period of about 2 months operation:

Statement

COST of operation of the Parseval air ship Pl. 6, making passenger runs in Munich from Aug. 3 to Oct. 8, 1910.

Income

Gate receipts to Aeropark	$ 5875
Receipts for passenger runs	5000
Price runs and visits to other cities	1125
Miscellaneous, post cards and photos	325
	$12,325

Expenses

Hydrogen	$ 1500
Weather service	550
Gasoline and oil	275
Repairs and maintenance	137
Salaries and wages	3625
General expenses	575
Insurance-fire, accident and liability	1538
Miscellaneous, illumination, freight propaganda, etc.	1075
	$9575
Net earnings	$2750

The net profits, although modest, are quite marked and considering the fact that this enterprise was the

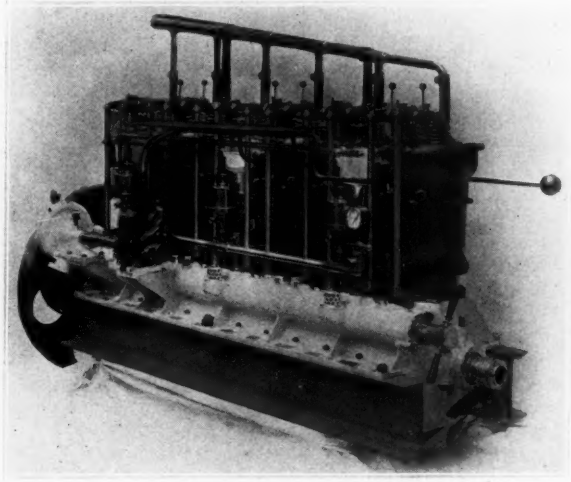


FIG. 7. THE MOST RECENT TYPE OF ENGINE FOR DIRIGIBLES

first venture without any previous business experience and stating further that the lucrative night advertising feature was not used in Munich, it stands to reason that a well-managed enterprise of this character combining the excursion and advertising features will show good returns.

Along these lines it might be mentioned that the people of Berlin were much surprised by a new and original form of New Year's congratulation. The great ship of the Parseval Air Transportation Co. appeared on New Year's Eve over the metropolis and passed the main streets unusually close to the ground. On each side of the huge bag were stretched large canvases of glittering material, on which appeared in great letters of light the words "Prosit Neujahr," meaning Happy New Year. As the ship had just returned from its gas charging station at Bitterfeld, about 120 miles from Berlin, and displayed this lighting phenomenon for the first time, it caused a great sensation. The ship took its course to the Royal Castle, circumnavigated that and other important buildings and finally returned to its dock at Johannisthal. This friendly New Year's greeting will always remain in the memory of many Berliners, to whom it appeared. From now on, however, this method of display will be quite frequent as many large business firms will use this form as the most up-to-date medium for advertising. For this service a charge of $25 a firm a night has been established and each display will be shown 20 times a night.

From reliable sources it is stated that German corporations either manufacturing dirigibles or interested in their commercial applications have at present an aggregate investment of over $6,000,000 and many of them are to increase their capitalization considerably in the near future.

WATER RHEOSTAT CONTROL

IN connection with the 3-phase locomotives, built for the Giovi line of the Italian State Ry. by the Italian Westinghouse Co. to haul trains running between Genoa and Milan through the Giovi Tunnel, water rheostats are used for the control of motor speed.

Each locomotive has power to start a train of 400 tons from rest to 14 miles an hour on a grade of 0.3 per cent in 2 min. The motor rating is 720 hp. at 3000 volts on current at 15 cycles per second and run at synchronous speed of 112.5 and 225 r.p.m. connected in series and in parallel respectively. Intermediate speeds are obtained by using the water rheostat.

Use of the water rheostat is one of the main advantages of the control system. It eliminates all metallic resistance parts, which are always more or less subject to burnouts and mechanical breakage. Moreover, all contacts that have to be operated under current in the secondary are eliminated except the one contact which short circuits the rheostat. On this contact, however, there is no arcing and burning, since it operates only when the water rheostat is about zero resistance. A further advantage of this control lies in the fact that it does not increase the current by steps, but allows of the finest possible regulation.

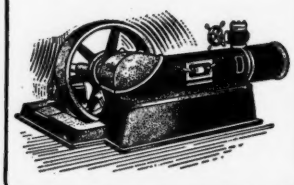
The water receptacle is a tight tank so mounted as to extend below the cab for air cooling. Receptacles for the electrodes extend from below the water level, through the cover and up into the lower parts of the locomotive, the electrodes being supported in the upper portions of these receptacles or cylinders. In operation the height of water in the cylinders is regulated by air pressure in the upper part of the tank which forces the water up into the cylinder and the regulating mechanism extends into the cab proper and can, therefore, be conveniently inspected after the removing of a protecting cover.

SYSTEMATIC PROMPTNESS lies at the foundation of success. Learn to drive your business, and never let your business drive you. Be careful what you agree to do, but do what you have agreed, and do it promptly.—William H. Baldwin.

GETTING THINGS DONE is a matter of first getting things started.—System.

Letters from Engineers

Bright Ideas direct from the plant. Send us yours. Cash paid for those accepted. Sketches desirable; we make the drawings



BABBITTING ECCENTRIC STRAPS

IT often becomes necessary to babbitt or rebabbitt an eccentric strap in an engine room. While this job is one somewhat dreaded by those not familiar with the work, it is simple if gone at in the proper way. Like all babbitting jobs, if you properly prepare for the job, you will have but little trouble doing it. Sometimes an eccentric becomes very much cut and it is necessary to babbitt it to make it so that it can be run. Sometimes it is necessary to file the entire eccentric block, which can be easily done, but care must be taken not to file flat places; one should file gently all around the entire surface of the block until smooth; you need not file out all of the cut marks on the eccentric strap, but the surface should be fairly smooth.

When you have finished the filing, make a dressing clamp shown in Fig. 1, which can be made of some small pieces of timber. Use some emery cloth beneath

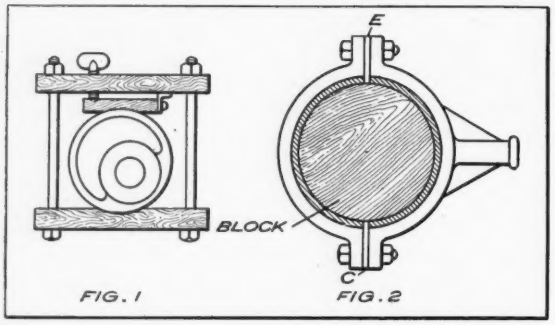


FIG. 1. DRESSING CLAMPS FOR ECCENTRIC
FIG. 2. BABBITTED CAST- IRON ECCENTRIC STRAP

a small rubber block; this block can be made of any kind of wood, soft wood will serve just as well as hard wood. The outside frame of this truing device should be bolted up firmly and the tension set on by the auxiliary block. This is a simple tool, but one of much value and it will work wonders on an eccentric that is giving trouble, as it will true up the surfaces and not leave bumps that would cause the bearing to run hot when started. It should be used with some diligence and care to insure a good surface. The block can be made to conform to the shape of the eccentric. When the eccentric has been properly prepared the strap can be babbitted. If it is a strap where iron to iron has been working the best plan would be to take the strap to some nearby shop and have it turned out so as to make room for babbitt, provided the strap has strength enough.

I have found in some cases, where much trouble was being experienced from the running of an eccentric, an excellent plan is to have a new cast-iron strap made, allowing the proper babbitt room, as babbitt running on cast iron is far better than running 2 like metals together.

There are 2 ways of babbitting the strap. One is to babbitt it on a form or block and have it turned out on a lathe to fit the eccentric. This makes a fine job when carefully done. In this case the babbitt can be poured in the strap as shown in Fig. 2, the strap being nicely centered up around the block and must have the necessary liners in the clamps at E C and the strap must be firmly bolted together. These liners preferably should be metal so as not to give from their original place when being re-clamped. The block may be nailed or fastened down.

When the babbitt has been poured the strap is ready for the lathe. It should all be turned as a solid mass and then sawed apart and the proper gap filed between the openings. When this has been done fit it to the cam. It should need but little fitting if the measurement has been carefully taken to the lathe man. When keyed on and found to be all right, cut some deep oil grooves and place the strap on eccentric, bolt it up firmly, and before connecting up the eccentric rod turn the strap around to see that it is free. Many strap jobs prove disastrous by failing to do this and will stick upon starting and break things up.

Some of our engine rooms are far from a lathe and we have to babbitt an eccentric strap right in place. This is usually, however, the kind that has been once babbitted. To do this, clean out the old babbitt and dress the eccentric block in the same manner if it is untrue. When ready to babbitt have 2 circular boards made so that they can be clamped over the shaft. Clamp these on each side of the eccentric and this job must be well done so as not to give way. The strap can be centered in place by placing some small pieces of babbitt around between the strap and the blocks; the strap must be firmly bolted upon the liners between the strap ears. In this case a pouring hole is left at the top. After clamping up the boards firmly some putty should be put around the crevices so that no metal can leak out when pouring, as a leak will necessitate doing all the work over again, so this is one of the points that should receive the proper amount of care. When the pouring is finished take the bolts out and break apart the strap and dress and fit by scraping, and cut the oil ways. This should be done in the same manner as in the other case cited. The points of the strap should always be relieved with a scraper so as to allow plenty of freedom for expansion. This is one point where many babbitting jobs become a failure. A strap which has been poured on the eccentric block and not turned out will require more relining at this point than one that is turned, on account of contraction from the heat of the babbitt.

C. R. McGahey.

GAGE READING

ON page 240 of Practical Engineer for March, under the heading, "Kinks for the Plant," Joseph S. Soddy would like to know, why, when the trap refuses to work, one gage registers 72 lb. per sq. in. and one gage 59 lb. per sq. in. The reason for the difference is, when the trap refuses to work the water rises over the inlet to the gage registering 59 lb. and as the difference between the inlet to the gage and the level of the gage is, according to the sketch, 30 ft., when the entrance to the gage is covered with water, the 72 lb. of air above the water forces the water up the gage line, and as the gage line is 30 ft. high and a column of water one foot high offers a resistance of 0.434 lb. to each foot in height you can readily see that $30 \times 0.434 = 13.02$ lb., or say 13 lb., and $59 + 13 = 72$ lb., which shows that the gages correspond with each other. John Mitchell.

ANTICS IN A SAW MILL

THERE is a saw mill near here that for the past year and a half has been performing a series of engineering feats, an equal of which, I doubt if any of Practical Engineer's readers can duplicate. The operators seem to know nothing of speed relations, or how to figure speeds, so when they decided their sawdust conveyor was running too slow they changed the pulley, then it ran so fast that there was no chance for the sawdust to drop through the feed to the boilers.

They made a water wheel to run a blower. Its minimum speed to be not less than 100 r.p.m. when finished they did get 6 r.p.m. once, without load.

They hammered a saw, using a stump for an anvil, and an 8-lb. sledge in the hands of a husky millman, and every inch from center to circumference shows the effect.

The climax occurred this week, and was caused in the same old way, saving expenses by hiring incompetent men.

The lubricator refused to work for them (I mention that it generally did), and they did not know how

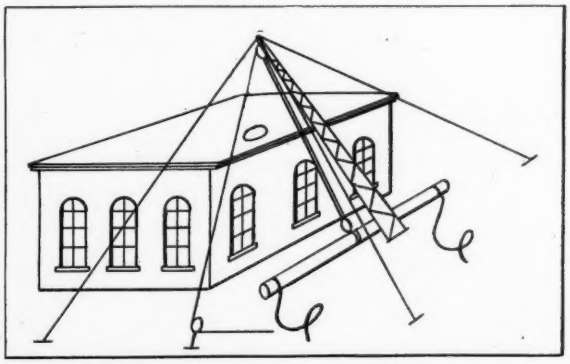


FIG. 1. LOCATION OF STACK BEFORE ERECTION

to fill it without stopping the engine. They ran all the afternoon until 5 o'clock without oil, when the eccentric rod broke between the eccentric and rocker. They got it repaired and started next morning, ran until 11 o'clock but could not keep steam enough to do much work, neither could they get the lubricator to work.

They stopped for steam and could not get the engine to start again, so opened the steam chest and found the valve broken through the middle longitudinally. The upper half was broken loose and had held to a lug until it had cut into the seat ½ in. deep.

The valve probably broke the day before when the eccentric rod broke, for a friend of mine happened to come in early that morning and tried to get them to stop and fix it, but they said the engine was all right except the crank pin was loose, and all the time the valve rod was jumping like a trip-hammer and steam coming from the gland full speed. They said they had the packing too tight at first so had loosened it.

John P. Durfee.

ERECTING A STACK

I SEE in my last number of Practical Engineer that J. W. M. wishes some information for raising a stack. I will give him suggestions gained from experiences I have had in this work. In the first place

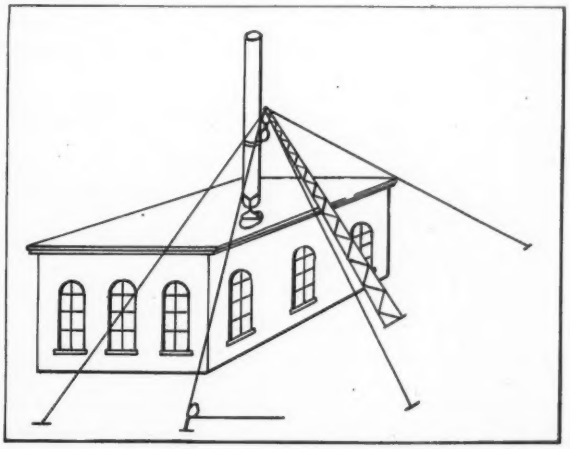


FIG. 2. METHOD OF HOLDING STACK WHILE ERECTING IT

he will have to place the stack along side of the building between the derrick and building, Fig. 1, then set the derrick so that the pulley in the top will be a few feet higher than the center of stack. If he can't set his derrick on the roof and must leave it on the ground, if the derrick is short he will have to hitch to the stack below the center, Fig. 2, and he must in this case tie a weight to the bottom of the stack or hold it with ropes to keep it upright, then when the stack is raised, have his men take the guy wires and pull it up straight to be let down on the boiler. C. A. Hay.

HEATING DRY KILNS

I HAVE noticed in recent issues of Practical Engineer some discussion of steam piping for dry kilns, and the feasibility of using exhaust steam for the kilns, and as I was at one time employed for some years at a plant where the exhaust was used in this way I contribute the following which might be of interest to some of the readers:

The exhaust from 2 slide valve engines was used throughout the day in a kiln which was about 75 by 125 ft., the horsepower of the engines is unknown to me but one exhaust pipe was 6 in. in diameter, the other 4 in. The engines were located 30 ft. from the kiln and worked at a steam pressure of 80 lb., the exhaust steam passed through coils made of 1-in. pipe located in a room built against the kiln wall and called the fan room, in it was a small slide valve engine driving a fan, the air from which passed over the coils, which were, of course, enclosed in the air passage

leading from the fan, the air after passing over and around the coils was forced through a wooden air duct, 3 ft. square, running the full length of the kiln, having openings in the top where it passed into the different stalls of the kiln. It is to be understood that the air duct was beneath the floor and the material to be dried was on cars above the floor.

The condensation from the coils was caught in a return pipe leading to a trap which discharged into a hot well supplied with water from the pump. The fan engine also exhausted into this well raising the temperature of the water considerably, in fact, to such a marked degree that it was pumped by the feed pump direct to the boilers, no heater other than the well being used.

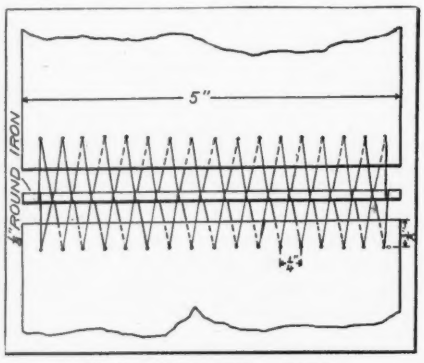
The largest exhaust pipe was fitted with a back-pressure valve, the other had a straight exhaust to the coils. Both engines carried fairly large loads and everything worked in a satisfactory manner, no trouble being experienced from back-pressure. The coils were heated by live steam during the night, a 2-in. pipe being used for the purpose.

At another plant I have in mind, a somewhat different plan was adopted, in this plant the engine was an 80 hp. slide valve, working at 80 lb. pressure, exhausting into coils placed in a kiln 25 by 90 ft. No fan was used at this plant, the material to be dried being on tracks directly over the coils. A back-pressure valve was used on the exhaust pipe which also carried a pressure gage, so that the pressure on the kiln can be told at a glance. A vacuum pump takes the condensation and vapor from the coils and discharges it into a tank over the boiler. All the pumps exhaust into the engine exhaust line so that the waste of steam is reduced to a minimum. The vacuum pump is fitted with a pump governor, thus making the pump's action entirely automatic, which insures the prompt handling of any volume of steam that may be exhausted into the coils.

At night live steam is used from a 2-in. pipe fitted with a reducing valve. The management of each plant claims that its way is best and most economical, but the fact remains that one plant shows as good results as the other, of course, each has its individual advantages and characteristics for the plant in which it is used. Le Roy Scott.

WIRE BELT LACING

I HAVE seen and read about a great many different kinds of belt lacing. Here is an illustration of one I have never seen in print. It is not my idea, but it is



BELT LACED WITH WIRE

in use where I am employed and I am told it is 5 yr. since it was laced. The belt is 5 in. wide, driving 7.5 kw. dynamo, running 6 days per week. The holes are punched ⅜ in. from the end of the belt and ¼ in. apart. The lacing is not crossed from one side of the belt to the other as in ordinary lacing, but is wrapped over a small piece of round iron ⅛ in. in diameter. All one side is laced around the iron before the other side is touched. In this particular case No. 17 gage brass wire is used. John Mitchell.

OIL IN BOILERS

WHY do so many talk against putting oil in a boiler for scale, etc.? I have used it for 10 yr. in a traction engine boiler in North Dakota with the very best results. I have used some graphite with the oil last year which I think makes it still better. Another engineer here in the electric light plant has used oil in his boiler for 14 yr. and no bad results have been discovered yet, the boiler is in fine condition.

I would be interested to know what success others have had with oil in boilers. J. J. Lee.

PUMP TROUBLE

A SINGLE cylinder boiler-feed pump after being repaired was run for a few months when it was noticed that the steam piston would not make a full stroke, but stopped about 2 in. from the cylinder head. When the drain cock was opened the piston would finish the stroke, but when the cock was closed, after a few strokes, the same old trouble appeared. Everything was in good condition at the water end, and the steam piston did not leak.

When the pump was taken apart everything was found to be all right except at the back end of the steam cylinder, there was some gummy substance between the piston and the head. The cylinder oil, which was of a very heavy grade, was responsible for the gummy substance mixing with the water. This matter could not work out of the cylinder, except by the way of the drain cock. When the cock was closed, of course it kept the piston from finishing the stroke. The piston and cylinder were cleaned, a lighter oil was used and there was no more trouble. William Goal.

DIAGRAM CRITICISMS

F. S. ASKS for criticisms of 2 indicator diagrams in the April issue of Practical Engineer. It is hard for any reader of the paper to criticise the diagrams with so little data available, although they are far from being perfect. I do not know what kind of a valve gear it is but I got some cards from a Wright engine some time ago that looked like the ones shown and after a few changes I got a good card.

Card No. 1. The rounded corner on the crank end steam line would indicate a worn catch block or loose connection on the valve rod. The drop in pressure is caused by the governor changing its plane owing to the poor valve setting on the low-pressure side, release is too early for an engine carrying steam as far in the stroke as this and the kinks in the compression are caused by the vibration of the indicator pencil due to the high compression on the low-pressure cylinder.

Card No. 2 shows too much compression on both ends. In the head end the steam is compressed to a higher pressure than the steam in the receiver and causes that loop at top left-hand corner and the steam valve on the crank end is forced from its seat just before the piston starts its stroke. Engines having such high compression are very troublesome, causing a jar or a tremble, and the journals running very hot

all the time. A little compression is good and helps easy running and is economical, but F. S. has too much for either.

C. E. D. shows a card from an old-timer. He does not get full boiler pressure on the head end card, it seems the valve don't open wide enough, and his release is too late; in fact, he has no release. The crank end is doing the most work. After a few changes along the lines I mention I think that Old-Timer will show up as well as a modern engine. M. J. C.

OVERLOAD DIAGRAMS

ENCLOSED are some cards taken this afternoon from our compound Corliss engine with high-pressure cylinder 34 by 72 in. and low-pressure cylinder 60 in. diameter. The pressure of steam in the boiler was 105 lb. and in the receiver 15 lb., with vacuum of 27 in. On the high-pressure cards the scale of spring was 50 lb. and for the low-pressure cylinder 20 lb. The engine was running at 60 r.p.m. The high-pressure cylinder rod was 5 in. in diameter and low-pressure 12 in. I would like to have the discussion of other engineers on these diagrams. F. T. B.

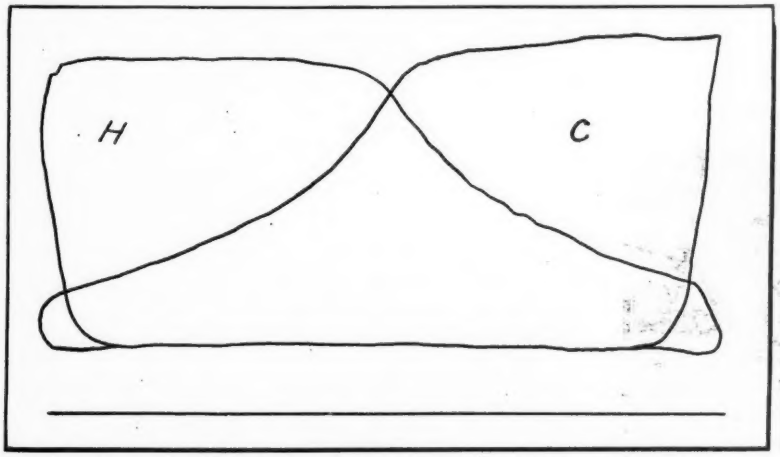


FIG. 1. HIGH-PRESSURE CARDS FROM WISCONSIN CORLISS ENGINE

OVERCOMING COMMUTATOR TROUBLE

SOME time I took charge of a plant and found I had considerable trouble with the commutator by burning a few bars flat and black. I tried for loose connections and short circuits but failed to find any. I turned down the commutator and before the week was up the same bars were as bad as before.

Then I examined the mica and found it carbonized down a short distance, but otherwise it seemed to be in good condition, but this seemed to be harder than the rest. I turned down again and then cut down the mica between the bars with a hack-saw blade, and from that time on I have had no more flat and black bars. It showed that the mica was harder than the copper. If there are any readers of the Practical Engineer similarly troubled, let them try this remedy and observe results.

John Fredrick.

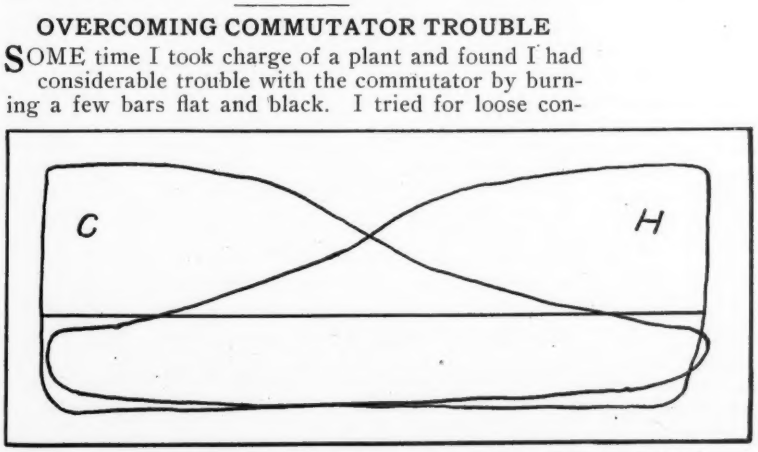
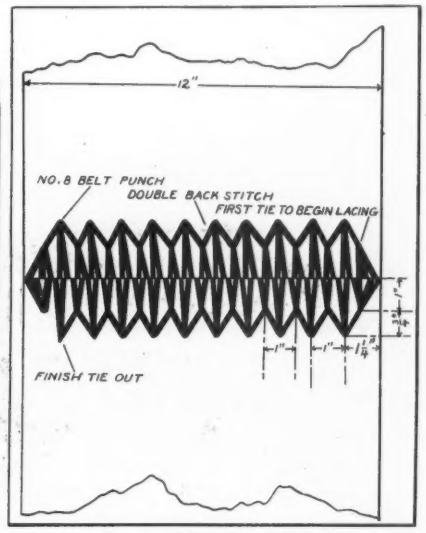


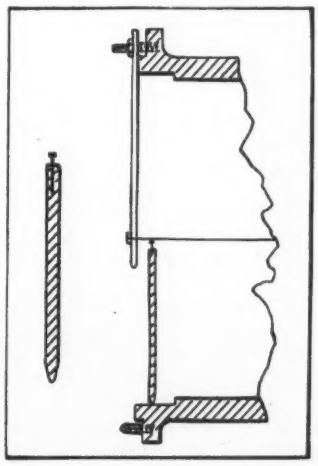
FIG. 2. LOW-PRESSURE CARDS FROM WISCONSIN CORLISS ENGINE

LACING A BELT

I AM sending you a drawing of a double hinge lace the purpose of which is to help out H. A. C. I do not say that the lacing is all the trouble that he is having with his belt, but do say if he will lace his belt like the diagram that he will not have to lace it 10 or 15 times a day. I have a 20-in. engine drive laced with this lace, and I only renew it about every 16 or 18 months. W. R. Craut.



DOUBLE HINGE LACE



CRUDE BUT ACCURATE CALIPER

ADJUSTING THE CENTER LINE

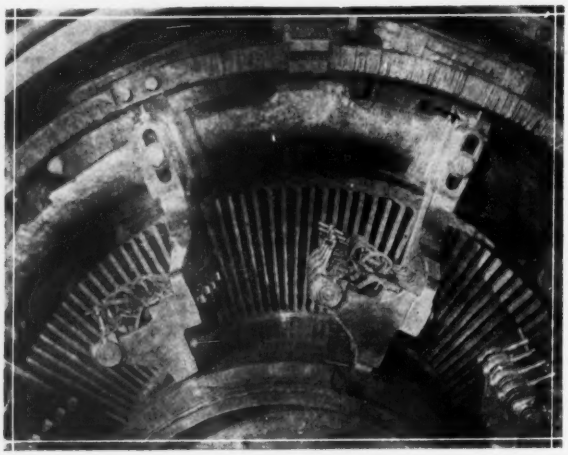
WHEN adjusting a center line through a large cylinder for lining guides a large pair of calipers are bunglesome and oftentimes the cause of a poorly centered string. A good way accurately to center the

line is to cut a stick about ¼ in. less in length than half the diameter of the counter bore. Sharpen one end somewhat, and insert a pin in the other. The wood, if soft pine or the like, will enable the pin to be pulled out or pushed in a trifle till the string has been truly centered. You can move a pair of calipers, but with this one you can be very careless and still keep the exact center. This crude micrometer is far more accurate than heavy inside calipers, is cheaper and posseses fewer possibilities of being jarred from size. F. W. Bentley.

COMMUTATION DIFFICULTY OVERCOME

IN the office building plant of which I have charge, there are 4 generators, direct current, 125-volt, direct coupled to 4 gas engines. Two generators are for 75 kw. and the other 2 are 110 kw. A singular thing about the generators is that the commutators of all 4 are of the same size, while the armatures of the 110-kw. machines are quite a little larger than the 75-kw. machines.

The commutators of the 110-kw. machines are of the same diameter as the 75-kw. but have 3 more bars



ADJUSTMENT OF BRUSH HOLDER

than the 75-kw. The 75-kw. generators have 6 brush holders, with brushes 1 in. thick, while the 110-kw. generators have 8 brush holders, with brushes only ¾ in. thick, thus giving each machine the same number of square inch brush surface. The 75-kw. machines always ran very nicely and never gave any trouble from sparking, while the larger machines with the narrow brushes were always giving a great deal of trouble until I tried out the following remedy.

I found that the brushes on the small machines covered 2 commutator bars and part of a third, while the brushes on the large machines covered only 2 segments, and I found that if the 8 brush holders were not spaced exactly they would begin to spark badly, and as the sockets, at point B, had become worn from frequent adjustment, the brush holders would get out of their proper alignment while in operation.

Noting that the smaller machines with the wide brushes never gave any trouble from sparking I decided to widen the point of contact on the larger machines. I did this by inserting a narrow 1/32-in. liner under the heel of the brush holder bracket where it clamps to the frame at B; this threw the outer end of the holder ¼ in. back from its original position, thus taking a line parallel with the commutator segment and touching the back corner of the back brush, and another parallel line touching the front corner of the front brush, I have a space one inch wide on which the whole brush holder makes contact.

Referring to the illustration the steel scale at A is lying parallel with the commutator segments. While the edge is touching the back brush, it can be seen that the front end is some distance from the brush. After lining up the brush holders of the 2 110-kw. machines in this way I have not had any more trouble with the brushes sparking. And these machines now run as good as the smaller ones. The brushes do not scratch and clatter as much as before and the commutator can be kept much cleaner and brighter. The narrow liners also had a tendency to hold the brush holders more accurately in their proper positions. I cannot observe that the efficiency of the machine is impaired in any way by the change. L. M. Johnson.

VOLTAGE DROP IN CIRCUIT

REFERRING to H. A. W.'s question in a recent issue, regarding the drop in voltage for 300 amperes, supplied to motors, at a distance of one mile from the genertor, I offer the following solution.

He has a No. 0000 wire circuit of a total length of 2 miles, 10,560 ft. The resistance of No. 0000 wire is 0.04966 ohms per 1000 ft., and 0.04966 multiplied by 10.560 equals 0.524 ohms for the entire circuit.

The drop for 50 amperes, following the rule that the drop in voltage equals the current time the resistance, we have: $50 \times 0.524 = 26.2$ volts. With a circuit of 300 amperes the drop would be 300×0.524 or 157.2 volts.

By using the constant 0.524 in his case and multiplying it by his ammeter reading at any time, he can tell in a minute just what his line drop is, and by subtracting this from the switchboard voltage in the generator room he can readily determine voltage of the current at the motors.

The only practical remedy for his power trouble, aside from moving the machines closer together, as he has suggested, is to put up more wire. Two No. 0000 wires in parallel would have just one-half the resistance, consequently the line loss or drop in voltage would be just one-half.

A practice which is being followed at some of the mines in this locality is to run the switchboard voltage from 15 to 30 volts higher than the generator rating, which will to some extent compensate for the line drop.

There is evidently a mistake in the rating given of his dynamo, as a 500 ampere, 250 volt machine, following the formula, k. w. $= V \times A \div 1000$, would be entitled to a rating of 125 kw. instead of 100, as he states. John Craig Scott.

STOPPING KNOCK IN PUMP; PULLEY SIZES ON QUARTER TURN BELT

IT may be that M. S. who described his trouble in the February number has a very light air leak around the piston rod of his pump which would prevent the cylinder from filling on one stroke, this at his pressure, or in fact any pressure, will make a bad pound.

If H. A. C. can put on larger pulleys maintaining the same ratio of diameters, his troubles will be over. H. E. Fisher.

THUMP IN CYLINDER

ALL thumps, clicks, pounds, and rattles issuing from an engine under way are caused usually by excessive play or slackness between the wearing surfaces. If the piston fits it will not thump, providing, of course, that the piston does not hit a shoulder in the cylinder wall at the end of stroke. Speaking particularly in regard to marine engines, moving the piston rod gland is poor policy. At best, it is only a makeshift in treating the effect and not the cause.

I had trouble with a vertical fore and aft compound non-condensing engine, 10½ by 22 by 12 in., running at 147 r.p.m., and supplied with steam at 160 lb. at the throttle. The low-pressure piston was fitted with 2 snap rings held out by a heavy inside snap ring. The piston pounded or thumped at the end of the up stroke, and as I thought that there was no life in the rings, I made up my mind to investigate at the earliest convenient time. The first chance I got, I jacked the low-pressure piston to the end of the up stroke, then removed cylinder head and follower plate.

In jacking the engine over the center, I found that the rings moved down with the piston. That showed that there was no tension to the rings, or they would have stuck to the cylinder as the piston moved away. So I placed strips of sheet iron between the inside tension ring and the outside snap rings and have had no more trouble since. Frank Caldwell.

BABBITTING ENGINE BEARINGS

IN the sketches are shown the 2 ends of the shaft with the rigging which will make clear the method I use in raising large engine shafts. At the crab end of shaft you will notice the blocking and bridge of

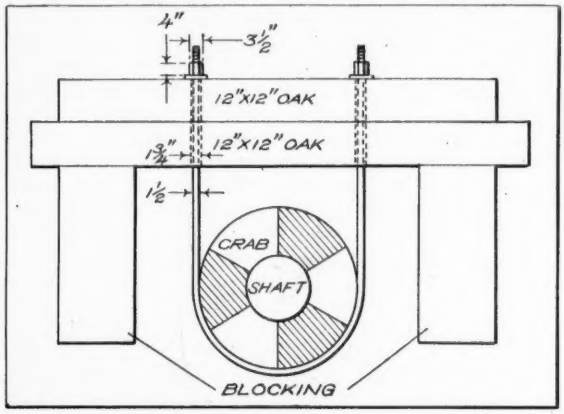


FIG. 1. SUPPORT AT CRAB END OF SHAFT

2 pieces of 12 by 12 oak, one on top of the other, also the stirrup around the crab and passing up through the timbers and held by washers and nuts. The stirrup is made of 1½-in. round iron with 2 ft. of 1¾-in. round for threads. The thread was cut in a lathe and welded up afterwards.

The nuts are hexagonal 3½ by 4 in. deep made especially for the job. On the crank end of the shaft we use a little different rigging. Owing to the large disk, 24 in. face and 90 in. diameter, we use straight rods with a long thread to do the raising and enough thread on the bottom end to lock 2 1¾-in. standard nuts. You notice the 12 by 12 at bottom of disk. We fit a piece of oak in each opposite port hole of the disk and let them extend out far enough for the 12 by 12 to catch on, with enough clearance to drop a plumb line down between disk and the log. The 2 bridges on top are at right angles with the bottom.

Our engine is a McIntosh, pop valve type, with a capacity of 800 hp., having a flywheel 25 ft. in diameter, the shaft being 22 in. in diameter and 14 ft. long supported in journals 18 by 30 in.; the entire weight is 60 tons.

The engine is built for running 4 sheet or jobbing mills 2 on each side, 2 coupled direct and 2 with gear

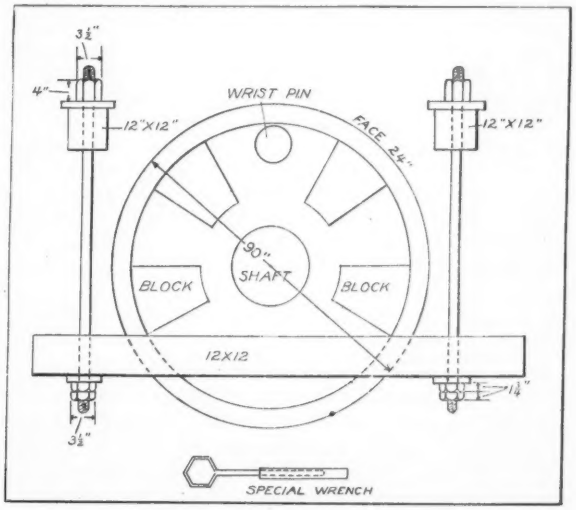


FIG. 2. RIGGING USED AT CRANK END AND STYLE OF WRENCH USED

wheels. To roll a heavy wheel and shaft up from side to side is a hard and slow job, and by the time it is high enough to cut out the old metal and lowered down again it is thrown out of place more or less, both side and end ways. And to adjust a heavy shaft that is resting on blocking is quite a job. But by lifting it up with the rods it is scarcely thrown out of place,

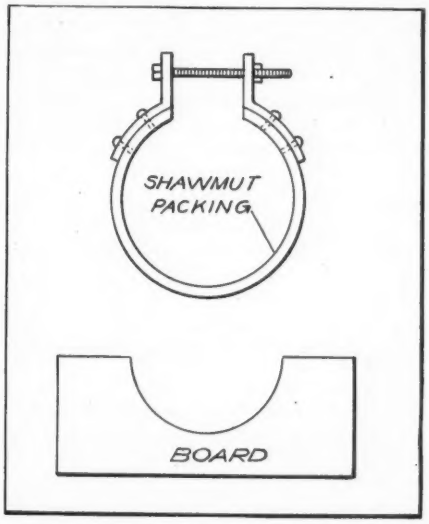


FIG. 3. APPLIANCES TO KEEP BABBITT IN BEARING WHILE POURING

and, being able to swing the shaft, it is easy to adjust both to line and level.

We rebabbitted our shaft bearings not long ago and from the time we started until we had the job completed, everything cleaned up and ready to go ahead, 4¾

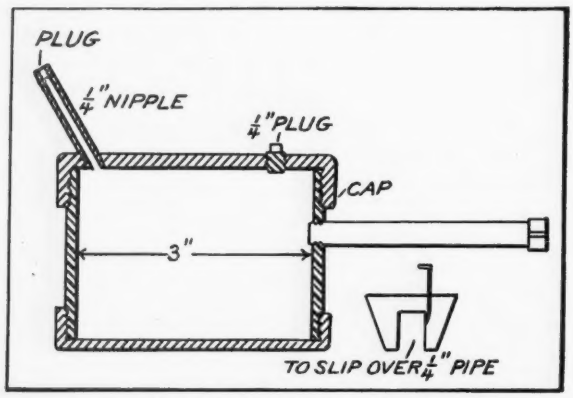
days elapsed, which I think was good time. It takes about 400 lb. of metal for each cellar box and about 90 lb. each for the 4 quarter chucks, making altogether 1160 lb.

After a shaft is lined and leveled great care has to be taken in preparing the journal to receive the metal, so that it does not run out while pouring. For small jobs stiff mud or fire clay will do to stop up the openings, but for large jobs it will take something that the weight of metal will not force off. The best way that I have found to fix up a large journal is to take a wide board and cut part of a circle in the board, the exact size of the shaft, so that the top of board will be over the metal line. Take a piece of heavy paper and put it between the board and plumber block, also bend it down in the circle of board. The paper will make a good gasket, also keep the hot metal from coming in contact with the board and prevent the metal from boiling. After the cellar boxes are poured the boards can be moved up for the side chucks. For jobs where it takes ½ to ⅝ in. of metal a draw band made of square Shawmut packing is fine.

John Treweek.

HOME-MADE GASOLINE TORCH

THE sketch shows how a cheap and extremely handy gasoline torch can be made of stray pipe fittings. The generating cup is rolled out of tin with a wire hook riveted in, to lay over the end of the nipple, and hold the cup while heating the fire tip.



HOME-MADE GASOLINE TORCH

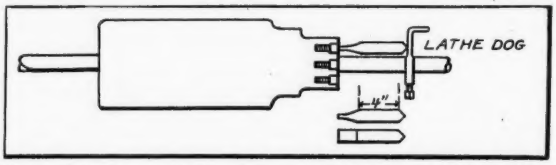
It is cheap, heavy and serviceable. The hole in the plugged end of the nipple can be drilled to suit the maker regarding the size of the flame desired. With all joints tight this torch is very safe and needs no compressed air to operate it. A. W. Bentley, Jr.

REPAIRING A COMMUTATOR

PUTTING new mica segments in the commutator of armatures is not so difficult, but to keep the copper segments from coming loose and projecting, causing the brushes to rattle, is the most perplexing problem that I have had for a long time. I would tighten the screws that pull up the mica ring as tight as I could with a wrench and screw driver. The commutator was turned in a lathe and was all right, but when put in the frame and let run for ½ hour, the bars would be loose.

It went along this way for about 9 months, making about 15 to 20 armatures. I finally learned and have a scheme now that makes this trouble a thing of the past. I tighten the screws with a screw driver as tight as I can by hand, take 2 blow torches, one on each side of the commutator, put a strip of asbestos paper around the commutator leads, when it is an enclosed commutator, and a strip of asbestos paper around the commutator leads and asbestos wool packing between the bars on an open commutator. Then I heat the commutator with the 2 blow torches until the alcohol burns.

The mica segments and ring are shellacked before being put into place. The heat of the commutator causes the shellac and alcohol to run, consequently a



SPECIAL SCREW DRIVER FOR TIGHTENING COMMUTATOR RING

blue flame will be seen all around the commutator if it is heated enough. Then tighten with a wrench or the special apparatus shown in the illustration and you will not be bothered with loose bars. The tool is flattened to a screw driver on one end and the other end is a round point.

BOILER INSPECTION?

HAVING seen and heard so much about boiler inspectors and inspection, I send a few lines to show how some of it is done. Nine times out of 10 when a boiler explodes the first thing is to lay the blame on low water or the engineer, although low water is now considered as an unlikely method of exploding a boiler and the engineer may have had charge of the boilers for years without an accident.

One thousand feet from where I work is a factory in which a large number of men and boys work. The same inspector who cares for our boilers looks over theirs, and 4 years ago he told me that the boiler at that factory was not fit to run and that he was going to condemn it, but he let it run 4 years longer before it was replaced.

In regard to my own plant, I have 1 80-hp. return flue and 1 30-hp. upright. The 80-hp. is no one knows how old and has 2 big patches on it where it has opened up cracks in different places since I have had charge of it in the last 7 years. The last time we cleaned it out was about a month ago, when it should have had its regular inspection. I got everything ready and the superintendent of the plant telephoned to the inspector. The answer given was: "Clean it out, fill it and fire it up. What do you want your boiler inspected for when it is all right?" It had been a year since the inspector was inside that boiler and when the last patch was put on he came and marked out where it was to go, but did not go into the boiler.

Now as to the other boiler, which we got second-hand, he inspected it before the firm bought it and told me that it was in good shape and was safe for 125 lb. steam pressure. I ran it 2 days and it had 7 cracks around the firebox so that we could not keep water in it and it also had to be patched.

I am not a kicker but I think that things like this should be looked after and the sooner Pennsylvania has proper laws and state inspectors who will inspect, the better things will be, if graft can be kept out of enforcing the laws, which is a hard thing to do in Pennsylvania just now.

The way it looks to me is this: If the insurance companies have inspectors to do that work, why not do it? not wait until the boiler blows up and then if they do find a piece of the boiler, examine it and make a big report on it and blame it on the engineer who was in charge and who in most cases is no longer able to defend himself. S. F. N.

STARTING A CORLISS ENGINE

ON page 302 of the April number appears one of those nondescript questions that we meet occasionally. "A Corliss engine that cuts off at ¼ stroke is stopped with the piston at the middle point of its travel and consequently with both steam valves closed. How would you start it?"

Here the flat statement is made that a certain Corliss engine cuts off at ¼ stroke, when it constantly varies with the load, in practice. We are also told positively that with the piston at half stroke, both steam valves are closed, which shows the bad effect of too much defective theory, and lack of sound practice.

Having expressed my opinion of the conditions named, I will answer the question. If I was in charge of a Corliss engine that was loaded to require a cut-off at about one-quarter stroke, more or less, and had stopped it with the piston at one-half stroke, to start it again I should open the throttle valve. That is all.

On page 304, question 4 appears as follows: "Draw 2 diagrams, first with 1 steam valve unhooked, and the second with both valves unhooked."

Whoever wrote that question either did it to catch the applicant for a license, or else he was densely ignorant on the subject himself. When one valve of a Corliss, or any other disengaging valve gear engine is unhooked, steam cannot enter that end of the cylinder, and if both valves are unhooked it is shut off from both, hence attempts to take diagrams simply give the atmospheric line, or show a partial vacuum in the cylinder. Of course the engine would have to be turned by some external power during this operation. The answer on page 305 is correct for valves that are hooked on, but that is not the question.

W. H. Wakeman.

REVERSING A FREQUENCY CHANGER

WE are operating in parallel 2 motor-generator, 3-phase, frequency changing sets, each consisting of a 25-cycle, 13,000-volt motor, a 60-cycle 2300-volt generator, and an exciter with terminal voltage between 70 and 110, all mounted on the same shaft and making 500 r.p.m. Being tied together in synchronism, synchronizing is very simple, consisting merely of repeatedly reversing the field magnetism of the motor of the incoming machine until the corresponding generator field poles in the 2 sets are opposite similar generator armature sections, so that the waves of the different phases in one correspond exactly to the waves in the phases of the other.

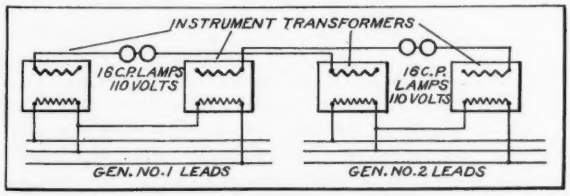


FIG. 1. LOCATION OF SYNCHRONIZING LAMPS

Through certain conditions not essential to this discussion, it became necessary to reverse the direction of rotation of one of the sets. This looked easy. We merely reversed 2 of the motor leads, and hopefully proceeded to cross and recross the generator leads, in the vain hope that we would strike a combination that would bring the 2 machines into step again.

We hung 2 16-cp. lights in series between corresponding pairs of potential transformers in the phases as shown in the diagram, Fig. 1, and finally found a combination of the 3 leads which made the 2 sets of lamps vary their brilliancy in unison, and at last become dark when the pointer on the synchronism indicator pointed a trifle on the slow side of the dial. Upon closing the main switch, however, the machine running carried all the load while the incoming machine ran unloaded.

We tried reversing generator fields, the only difference now being that the incoming machine took all the load. After considerable difference of opinion between the men who ought to know, the final conclusion was that there was a difference of angular relation between the motor and generator fields on the 2 sets, so that when the poles of the motors coincided, the generator fields did not, this caused the incoming machine to generate waves of e.m.f. slightly behind those of the running machine.

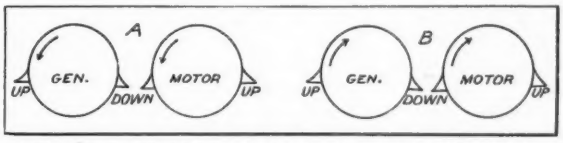


FIG. 2. METHOD OF CHANGING PHASE RELATIONS

It was impossible to shift the fields on the shaft, so the expedient of twisting the motor and generator armatures with relation to each other was hit upon. This was done by shimming up 1 side and lowering the other of both motor and generator armature frames, as indicated in Fig. 2. Here A represents the machine coming in and behind in phase, therefore taking no load. The armature of the generator was turned so as to meet the field and the armature of the motor turned in the opposite direction or with the direction of motion of the field. The other machine, B, ran ahead in phase and took all the load. In a similar manner its armatures were turned as indicated. This caused waves in the slow machine to come earlier and in the fast machine to come later, until finally, after a tedious lot of jacking and moving, the machine came into step and divided the load evenly. To keep the air gap even all around, the bolts holding the armature to the frame were turned off slightly so as to give a slight freedom of motion, and the gap adjusted, after which new dowel pin holes were drilled and pins inserted. The machines are running as well as ever now.

The exciter was reversed in polarity by its reversal of rotation—so the field leads were crossed. Ordinarily an exciter can be brought to right polarity by holding the brushes off the commutator, cutting in nearly all of the field rheostat and closing the main switch for an instant. Be careful that brushes do not touch or a short circuit through armature and series field will result. This method of course applies only when several exciters are operated so that the bus bars are alive. In our problem we would have had to change the equalizer if we had used the latter method—so preferred to cross field leads as stated before. V. E. Johnson.

Questions and Answers

To help you when in trouble; give name and address. If quick answer is wanted, enclose a stamp for reply.

THE CHIEF ENGINEER'S CATECHISM—I

WHAT does B.t.u. mean?

2. Give your reasons for or against buying coal on a B.t.u. basis.

3. Explain the difference in formation and qualities of anthracite and bituminous coal.

4. Do high or low grade coals make the more smoke, and why?

5. How many square feet of heating surface are allowed per horsepower in different types of boilers?

6. Where do you recommend discharging feed water into a boiler and why?

7. What process in firing will produce the highest efficiency from the coal?

8. Will the same furnace burn all kinds of coal equally well, and if not, why not?

9. What is the lowest draft possible for good furnace combustion?

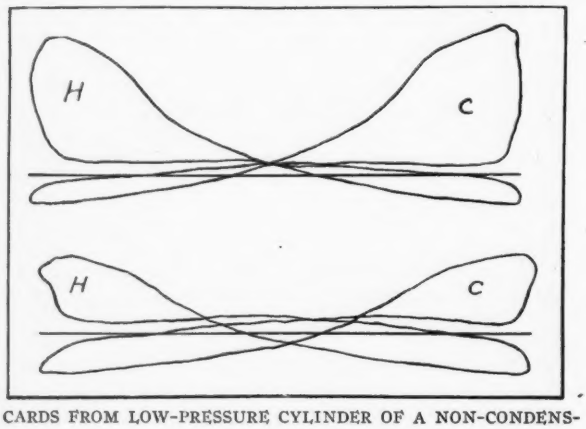
10. Is a high stack with small area or a short stack with large area to be preferred, and why?

(The best set of answers to these questions will be paid for at the regular rate and the author of the second best set will receive a prize of $3, with the privilege of using such of these answers as desirable. Answers to these questions should be received not later than June 1. Editor.)

Loop in Diagram

PLEASE explain the loop on these cards and how I may remedy it. This is a 18 by 36 by 38 in. cross compound, non-condensing engine. Samuel Meadows.

A. The difficulty is simply that the expansion of the steam carries the pressure below back pressure. The



CARDS FROM LOW-PRESSURE CYLINDER OF A NON-CONDENSING ENGINE

low-pressure cutoff is set so long that it pulls the receiver pressure too low. You should shorten up the cutoff on the low-pressure cylinder and run up the initial pressure in the receiver. This will throw more of the work on the low-pressure and less on the high-pressure and give the low-pressure a chance to expand fully without forming so big a loop.

Your engine is evidently under-loaded so it may be that you will get a loop in the low-pressure card in spite of this change, but shortening the low-pressure cutoff will tend to help matters.

Muffler Information Wanted

WE are about to install a 500-hp. gas engine and would like to be informed through the columns of Practical Engineer how to muffle the exhaust. Any plans or sketches from engineers of experience would be appreciated. C. E. Nigh.

Turbine vs. Engine

ADDITIONS to our plant will probably be installed this summer which call for more power and are installing stokers under our Stirling boiler. We will have to have steam engines or turbines for electric power, about 500 kw. We have considered a cross compound engine of the most economical type, also the turbine has put in its claims, if we can maintain a vacuum of 28 in. This seems to me hard to get in summer, as we use river water for condensing, which would average about 70 deg. What do you think would be the economy of the turbine with 28 in. vacuum as compared with the cross compound engine, with steam pressure at 150 lb., and will it be good economy to install a low-pressure turbine with 25 in. vacuum? J. M.

Portable Condenser

WE are using a portable steam engine on this island, in a country where water is scarce. We have thought that a condenser that would save at least a part of the water could be made by taking 3-in. corrugated rain spout in 2 lengths of 250 feet each, exposed to the air, for the engine to exhaust into.

The engine we have has a capacity of 22-hp. Our only object is to save water, increased efficiency is not expected.

How much water do you think we could save?

French & French.

A. Condensing exhaust steam requires the taking out of a good deal of heat, and air currents alone will not do this rapidly enough to be of much assistance. The current of steam through a pipe 3 in. in diameter would be very rapid and would not allow time for the air to take up much heat, and, besides that, after a little time the inside surface of the pipe would become coated with oil which would reduce the heat transmission.

The only feasible method of saving in your steam consumption would seem to be the use of an open feed-water heater. This would condense some of the exhaust steam and the careful adjustment of your en-

gine to keep the steam economy as good as possible would also save on the water to be used. If it were possible for you to arrange the rain spout sections in a trough so that the boiler feed water would flow over them you could get quite an effective condensation. If they were immersed in a trough where the water stood still, it would not help greatly. Even if the same water were arranged to flow over these pipes, repeatedly passing back and forth, it would help quite a little.

Intercooler Pressure

WHAT pressure should be maintained in the intercooler of an air compressor, when the low-pressure air cylinder is 18 by 18 in. and high-pressure air cylinder 8 by 18 in. compressing air at 250 lb.? W. W.

A. Compressing to 250 lb. gage means a ratio of 265÷15=17.7 total. The ratio between cylinders is as 18^2 to 8^2, which is 5.01. Compression in the high-pressure cylinder must, therefore, be 17.7÷5.01 or 3.53, and multiplying 15 by 3.53 gives us 53 lb. absolute as the intercooler pressure, or subtracting 15 would be 38 lb. gage.

Heating Surface of Boiler

HOW many square feet of heating surface are allowed per horsepower in the following types of boilers? In the calculation is it customary to add in the area of the heads? In the horizontal return tubular boiler do you count 2/3 of the shell or ½ for heating surface? Below are the types of boilers that I have reference to: Upright tubular locomotive, 2-flue Lancashire boiler, plain cylinder, horizontal water tube, return tubular marine boiler, Scotch boiler, and the portable return tubular such as made by Donegan & Swift.

A. There is a difference in the method of figuring the heating surface for reckoning boiler horsepower. Some authors figure this at 2/3 of the shell, others at ½. It depends, really, on the way that the boiler is set. If it is so set that 2/3 of the shell comes in contact with the gases, then 2/3 should be used, but even when so set, the part above the center line gets comparatively little heat, as the gases do not work up into the narrow space above that line, so that the argument for using ½ of the shell has very good reason for acceptance.

The rating of boiler horsepower depends on the evaporation of practically 30 lb. of steam per hour per horsepower, and for several types this is given by Snow in his book on "Steam Boiler Practice" as follows:

Lancashire, 7,
Cylindrical multi-tubular, 11½,
Vertical Manning, 11.1,
Locomotive type stationary, 12.6,
Scotch marine, 3.3,
Water-tube with steam drum, 11,
Water-tube with separating chamber, 7.3.

The portable return tubulars that you mention would be the locomotive type stationary boiler.

Troubles with a Donkey Engine

THERE isn't any book on donkey engines, so far as I can discover. There is plenty written on stationary engines, but that material doesn't seem to fit a plant that is out in the back woods where you get out only once a month and where your troubles are more numerous than your comforts.

One man in the last issue of Practical Engineer wrote complaining about the stuffingbox. He ought to have a trial on the donkey engine that I am running. You have to take the eccentric rod off to get into the stuffingbox at all, and everything else is just as handy as that. The water glass is around on the opposite side of the boiler from the throttle valve, and in order to see it the man at the throttle has to step back behind the boiler to know how things are going. We need more information on the handling of donkey engines. Are there not other engineers running such engines who would like to exchange ideas? Let's start something. M. S. A.

Point of Cutoff

AN engine has 20-in. stroke, 1⅜-in. lap and 5-in. valve travel, at what part of stroke will cut off take place? M. A. P.

A. There are some problems that cannot be worked out by arithmetic and the one that you have presented is in this class. The only method by which this can be worked out with figures is a process of analytical

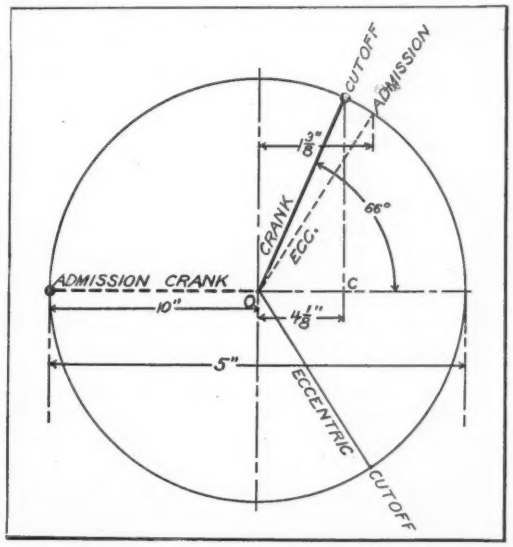


DIAGRAM FOR FINDING CUTOFF POSITION

geometry and differential calculus, which may bother you worse than graphical diagrams.

In the first place, the point in the stroke at which cutoff will take place depends on the angle of advance as well as on the lap and valve travel. The graphical method of working this problem is very simple and is shown on the diagram.

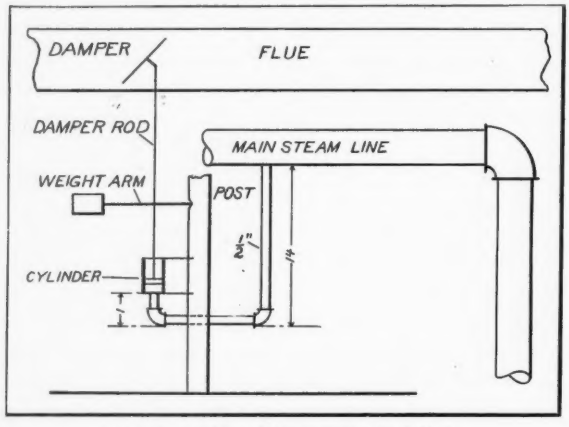
We have assumed here that admission is to come at the beginning of the stroke with no lead. If the eccentric were turned forward, so as to give lead, the point of cutoff would be brought correspondingly earlier. The dotted lines show positions of eccentric and crank at the beginning of the stroke. The valve circle is drawn ½ size and the crank circle is ⅛ size. The crankpin and eccentric center would then fall on the same circle. The full lines show the crank and eccentric positions at cutoff. The point of the stroke at which cutoff would take place will depend on the length of the connecting rod because the angularity of the connecting rod comes into the problem. If this angularity be neglected, the distance that the piston has moved up to cutoff will be half the stroke plus the

distance from the center O to the crank position projected on the diameter of the crank circle, or O C.

If the connecting rod angle be taken into account, the position of the crosshead must be laid out from crank position at admission to find the beginning of the stroke, and from the cutoff position of the crank to find crosshead position at cutoff, and the distance between these 2 points when drawn full size will be the part of the stroke passed over up to cutoff. This distance divided by the total length of the stroke will give the part of the stroke up to cutoff.

Damper Regulator Action

IN the sketch is shown a damper regulator attached to a post directly under the smoke flue. The damper regulator consists of a small 2½-inch cylinder, piston, piston and damper rod, weight arm pivoted to post, and ½-in. steam connection on the under side of piston; the ½-in. steam connection is taken from



DAMPER REGULATOR PIPING SYSTEM

one of the steam lines as shown in the illustration. The damper closes when steam pressure reaches 90 lb. and does not open again until pressure drops back to 79 lb., which is 11 lb. variation.

The ½-in. steam connection taken from a steam line has a drop of 14 ft., which remains full of water. A brother engineer said if I cut off 13 ft. of this drop by raising the damper regulator, the damper would open with about 5 lb. variation instead of 11 lb. The steam pressure on the under side of piston closes the damper and the weight arm opens it when the pressure falls on under side of piston. Would the change suggested improve the operation of the regulator? J. V.

A. The length of water column under your damper regulator piston will affect the working only because of the friction of the water in that long pipe. The head of water lifts on the weight arm but there is weight sufficient to prevent the lifting by this head of water, therefore as soon as the pressure drops there will be weight sufficient to overcome the head of water.

One cause of difficulty will be because when the weight lifts and the piston rises, the cylinder fills with water. When the piston falls this water must be forced back through the ½-in. pipe, which will probably fill with the condensation running along the bottom of the main steam line, and as the area of the 2½-in. cylinder is 4.9 sq. in., while that of the ½-in. pipe is 0.3 sq. in., if the piston rises 1 ft. it takes all the water out of the drop leg when it rises, and when it falls must force all this water back up through the drop leg into the steam pipe.

Pushing this back through a ½-in pipe involves a good deal of friction and under these circumstances, no doubt, raising the damper regulator cylinder will very much reduce the difference in pressure required between closing and opening the damper. Of course, the friction should be made as small as possible all the way through, because it is this matter of friction which causes the difference between opening and closing pressures.

Estimating Lamp Consumption

I WISH to know how to calculate the consumption of an incandescent lamp by timing the revolutions of the disk of a direct reading wattmeter. I read some time ago that the rule for doing this is to time the disk in seconds and divide the constant 3600 by the number of seconds it took the disk to make 1 complete revolution for a direct reading meter, and if the constant for the meter was ½, to take 1800, which was ½ of the constant.

For instance, if the constant of the meter was ½ and it took the disk 32 seconds to make 1 revolution, you divide 1800 by 32, which gives 56 and a fraction, which would be about right for a 16 cp. carbon lamp.

Now that does not seem to figure out just right. I have tried it on a Westinghouse Electric & Mfg. Co. direct reading single-phase 60-cycle wattmeter. I want to know how to figure it out at short notice. It is easy to time your meter for an hour or so and tell what it is doing by reading off the dial, but I wish a shorter rule, and there must be one. But whether one rule will apply to all or not is a question. S. B. Roper.

A. Your method of figuring the watts consumption of incandescent lamps from the revolution of the wattmeter disk is correct. If we find the time in seconds of 1 revolution of the hand which indicates watts, divide this into 3600, the number of seconds in an hour, it will give the number of watt hours, and this divided by the number of watt hours, which in this case would be 1, would give the watts registered, provided, of course, that the constant of the meter is 1. If the constant be ½, we should have to multiply by ½.

The indicating watt hand is usually on a small circle at the right of the registering dials. In some meters this makes 1 revolution to a revolution of the meter disk and in others it does not. Put into the form of a rule it would be: Divide 3600 by the seconds required to register 1 watt and multiply by the constant of the meter.

Furnace Draft

I HAVE a blower furnishing 4 oz. of air for a furnace and would like to know what would be its equivalent in inches of water of natural draft. Could you give me the rule for finding it? A. O.

A. A draft of 1 in. of water equals 83.2 ounces per square foot, or 0.58 ounces per square inch. Presuming that your 4 ounces is per square inch, it would be equivalent to 4÷0.58=6.9 in. of water, which is a pretty stiff draft. On the other hand, if you have 4 ounces per square foot, your draft will be 4÷83.2, which would be 0.048 in. of water and that would be a very small draft.

PEOPLE WHO NEVER start things, never finish anything.—System.

ANSWERS TO PRACTICAL QUESTIONS

Given on Page 182, February Issue

By John Mitchell

IN a tandem compound engine the 2 cylinders are placed in line, the 2 pistons being attached to the same piston rod. The high pressure cylinder is the one which first receives steam from the boiler. After the steam is expanded in the high-pressure cylinder it passes to the low-pressure or large cylinder, from here the steam is exhausted into the atmosphere or into a condenser.

A cross compound engine has 2 piston rods and 2 cranks, the cylinders being placed side by side. In any compound engine without a receiver, the 2 pistons must begin and end their stroke at the same time and the 2 cranks must be together or placed 180 deg. apart. Most tandem engines have no receiver while nearly all cross compound have receivers allowing the cranks to be so placed as to keep a more uniform pressure on the shaft.

2. A vacuum is used with a condensing engine on the exhaust side of the engine.

3. Waste cocks are placed on an engine to let the water or condensed steam out of the cylinder and chests.

4. The horsepower of an engine equals the mean effective pressure, P, times the length of stroke in feet, L, times the area of the piston in square inches, A, times the number of strokes a minute, N, divided by 33,000. For the problem given $P = 40$ lb.; $L = 15$ in. or 1.25 ft.; $A = 10^2 \times 0.7854 = 78.54$; $N = 250 \times 2 = 500$. Then $40 \times 1.25 \times 78.54 \times 500 \div 33000 = 59.5$ hp.

5. To keep a boiler from foaming keep your boilers free as possible from grease or oil. If you are working the boilers at the time of foaming feed your boilers as evenly as possible, fire more steadily, and if compulsory slow down on your steam valves.

Answers 5a and 6 are from Franklin F. Damon.

5a. Frequent blowing down and cleaning out a boiler will prevent foaming if feed water is not too dirty.

6. The steam gage shows the pressure inside of the boiler, that is, the pressure in pounds, per square inch, above the atmosphere.

7. The sleeve, in which the valve spindle of the throttle governor slides, and the governor balls are made to revolve by being connected by belt or gearing to the shaft and the bevel gears on the throttle governor. If the engine moves faster than the desired speed, the fly balls are forced to revolve at a higher speed, and will, consequently, move outwards and upwards through the action of centrifugal force. This action forces the valve spindle down and partly closes the throttle valve. The engine thus takes less steam, and the speed falls to that desired, the governor balls in the meantime return to their original position. Should the resistance become greater than the power of the engine, it slows up slightly, the balls drop, and opening the valve wider more steam is admitted, and the engine again resumes its original speed.

The governor as applied to automatic cut-off gear, such as Corliss engines, varies the point of cut-off, instead of regulating the steam supply. The motion of the governor is obtained by means of a belt and bevel gears from the shaft to the governor balls. Let it be supposed that the engine is running at its normal speed, the fly-balls will then be held in their normal position by the balance existing between the centrifugal and gravity forces acting on the balls.

Suppose, now, the speed of the engine increases from any cause whatever, the centrifugal force acting on the fly balls will also increase and will continue to pull them out, that is, to increase the diameter of the circle in which they rotate, until a new balance is affected between it and the attraction of gravity. This movement of the fly balls will be transmitted to the lever causing it to turn slightly about its center, this lever is connected to the governor and connected by rods to the collars on which are placed what is known as trips. The movement of the lever will cause the trip collars to turn through a small angle in such a direction that their trips will unhook the disengaging hooks earlier in the stroke. This will cause the point of cutoff to occur earlier in the stroke, and will decrease the speed of the engine on account of the reduction in the amount of steam admitted to the cylinder, and because of an increased ratio of expansion of the steam with the same initial pressure.

Should the speed from any cause diminish, a reverse operation will be the result. The fly balls will drop slightly, the lever on the governor will turn slightly in the opposite direction thereby turning the trip collars in the opposite direction and cause the trips to unhook the disengaging hooks later in the stroke, the cutoff will then occur later in the stroke, and a diminished ratio of expansion at the same pressure will again bring the speed up to its proper point.

8. The principal defects of an engine, under ordinary conditions, that has stood for one year would be rust and dirt in the movable parts and oilways, and hardened packings.

9. To set a simple slide valve, first put your engine on dead center. A common method of doing this is, when the crosshead is near the end of its travel, make a mark on the crosshead and guide in line with each other, then make a mark on the edge of the flywheel using some kind of a tram, measuring from the floor to the mark, then continue to turn your wheel in the same direction until the marks on the crosshead and guide come together again, then make another mark on the flywheel using the tram. Half way between the 2 marks on the flywheel is the position of the flywheel at dead center.

Continue turning the flywheel in the same direction and proceed as above to get the opposite dead center, when you have got the dead center of both ends you can proceed to set your valves. One thing should be borne in mind here, never turn the engine backwards or in the opposite direction as the lost motion in the connections is liable to affect your dead centers.

Now proceed to set your valve, with your engine on dead center place the valve on its seat and connect it with the valve rod, shift the eccentric on the shaft until the valve has the desired lead, which will depend on the size of the engine, valve, and port holes; fasten the eccentric on the shaft; turn the engine in the direction it is to run until it is on the other dead center; if the lead is the same at both ends the valve is correctly set, if it is not the same, the valve rod must be lengthened or shortened until the lead is the same at both centers. If now, the lead is less than desired, shift the eccentric a little forward on the shaft, if the lead is a little too great, shift the eccentric a little backwards. After the valves are set and the engine is started, a set of diagrams should be taken and refinements of setting made.

10. The most important thing to be put on a steam head between the boiler and engine is a stop valve, the next most important a separator and the next a lubricator for cylinder oil.

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ANOTHER EXPLOSION

This time it is not the boiler that is damaged, but the setting. A careful experiment, quietly conducted, has been inserted under one of our cherished precedents and conventions, and behold, a large part of the boiler settings are proved to be wrong.

In many things, we go on year after year, doing things in a certain way because they have been done that way,—a petrified rule of thumb performance with no reasoning introduced. Then comes someone with an interrogation point in his system, makes some investigations as to "why?" and our cherished conventional method goes glimmering. Theory does not always accord with the fact, and then it is wrong theory. But, where facts do not agree with past practice it is time to give up the practice as quickly as we would the theory.

The government investigations on fuel and furnace conditions under the efficient direction of Dr. Joseph A. Holmes, have discovered a lot of things for us. They have found out how to do a lot of things which we didn't know how to do, and the latest announcement is that we don't know how to do something which we thought was all settled.

It has been an unquestioned custom to build the side walls of boiler settings with an air space to prevent loss of heat. In an investigation of the flow of heat through furnace walls, made at the Pittsburg Fuel Testing Plant, and the results of which are announced in a bulletin by Messrs. Ray and Kreisinger, it is shown that so far as loss of heat is concerned a solid wall of brick is preferable to a hollow wall of the same total thickness.

If it is desirable to split the wall in order to avoid the spreading of through cracks, the space between parts should be filled with some kind of non-conducting material in loose form, such as sand or ash. This is because heat, while it travels slowly through air by conduction, jumps over a narrow air space readily by radiation, and by careful thermometric measurement it was found that the drop in temperature, which is a measure of the effectiveness of any medium to prevent the flow of heat, was small across the air space as compared to the drop through a like amount of brick wall, and very small compared with the same thickness of space filled with asbestos.

Another interesting fact pointed out is that while the conduction of heat through a solid wall or body depends on the difference between the temperatures of the 2 planes at the surfaces of the body, the quantity of heat passing across the air space in a wall depends on the difference of the fourth powers of the absolute temperatures at the surfaces of the air space. It follows, therefore, that for a given temperature difference between the 2 sides of the wall, the amount of heat conducted is the same, regardless of what the 2 temperatures may be; but in the case of an air space, the radiation increases rapidly with the temperatures of the enclosing surfaces, even though the difference in temperature may be the same.

It follows that if an air space be used, it should be

kept at as low a temperature as possible instead of being put, as has been customary, between the fire brick lining and the common brick. The experiments show that it should be put as far from the inside as possible, so that before the heat reaches the air space it will have dropped to as low a temperature as possible. The real right way is to fill this space with ash, sand, or mineral wool.

And so this innocent looking little investigation with the application of the laws of physics established has overthrown the correctness of every boiler setting built with an air space in the wall. It forces us to revise at once our standard plans for boiler settings, and makes it advisable to take steps to fill up all those air spaces with sand and ash. It is another illustration of the tremendous power of a fact.

WHAT DO YOU KNOW?

Beginning with this issue a series of questions, "The Chief Engineer's Catechism," will be presented in Practical Engineer on subjects of vital interest to the men in charge of the power plant. One month will be given for the preparation of replies and the answers to each series will be published in the second issue following that in which the questions appear.

The best answers to each series of questions will be paid for at regular space rates when published, and the author of the second best series will receive a prize of $3, with the privilege of using such of these answers as seem desirable. The answers to the questions in this issue should be received in the office of Practical Engineer by the first of June. Answers should be full rather than brief, but not unnecessarily long.

ENGINEERS TAKE NOTICE!

J. G. Leasure, who for some time has been taking subscriptions for Practical Engineer in the Pittsburg territory, including Western Pennsylvania, West Virginia and Southern Ohio, is no longer connected with Practical Engineer. It has been necessary to discharge him from our force because of irregularities in his financial transactions and we would warn all subscribers from paying any money to him on our account. Money due on subscriptions should be sent directly to this office in order to receive credit.

CORRECTION NOTE

IN the April issue, on Page 291, first column in the article on Principles of Refrigeration, by C. F. Swingle, the first line in the first column is out of place and should be at the bottom of the second column, a part of the article on the Ammonia Expansion Valve. Also, in the last paragraph of the article, in the first column, in the 7th line of that paragraph it should read: "and forced back through the economizer or heater G into generator A, to be re-evaporated."

AMERICAN SOCIETY of Mechanical Engineers will hold its spring meeting in Pittsburg, May 30 to June 2. Headquarters will be at Hotel Schenley and professional sessions will be held in the Carnegie Institute Wednesday morning and evening and Thursday and Friday mornings. Inspection trips to industrial plants, a boat excursion and reception, and a smoker attended by the Engineers Society of Western Pennsylvania are included in the entertainment program.

ECONOMIC ASPECTS OF THE INSTITUTE OF OPERATING ENGINEERS *

BY J. C. JURGENSEN

THERE was a time and a state of the public mind, when the business of running boilers and the taking care of power machinery was looked down upon. Operating Engineering as a vocation, was thought unworthy of educated and cultured men. But happily that time is passing away.

That this childish understanding of the needs of the vocation has so largely existed even among Operating Engineers and still exists may be partly ascribed to the comparatively recent realization of the vocation's economic importance. Men following Operating Engineering have for this reason not yet done much to define their position, or to insist upon standards of training and education among themselves.

That operating engineers themselves have not seriously attempted to grade their members in accordance with merit and ability, has done more than any other cause to discredit the business standing of operating engineers.

The Institute will endeavor to inculcate a deep sense of vocational pride, in the sincere and honest belief that pride of vocation is one of the prime essentials for the elevation of operating engineering standards, and hence the economic well being of the engineer.

Organizers of the Institute are aware of the evolutionary characteristics of this vocation's development. One important sign of this evolution, is the sudden change in the attitude of educators and of the far-sighted business managers as to the economic importance and standing of the operating engineer. Two facts which especially mark this change are, the repeated advice of colleges to their students to take up as a profitable life work the management and the operation of power plants; and the growing willingness among professional engineers to give professional standing to operating engineering. This willingness was emphatically shown by Prof. F. R. Hutton of Columbia, in his Presidential address to the American Society of Mechanical Engineers, at its annual meeting in December, 1907.

Prof. Hutton gives close attention to the historic definition of engineering, which was given by Mr. Tredgold; "The art of directing the great sources of power, for the use and convenience of man." Prof. Hutton says, "He who commits himself to the splendid Tredgold definition must take its alleged defects with its excellencies." One is that, "It includes as Engineers, not alone those who create and install appartus to control and use the powers of nature, but also those who control and direct the machines or apparatus when created and installed.

"Such a man also directs and controls the powers of nature, although on a less exalted plane than the creator or designer or co-ordinator. There are those, who would make the co-ordinator appear as a mere purchasing agent, and the Operator as a mere craftsman, and neither an Engineer. I cannot agree with them, believing that their function calls for skill and acquirements of a high order. The historic definition unquestionably provides for them."

* Abstracted from an address before the New York branch.

Judging from what is said, there would therefore seem to be good ground for the Institute to claim professional standing for those of its members who have acquired the knowledge of operating, and managing with economical results the modern power plant with its many sided requirements. At any rate it proves conclusively that the operating engineer must be trained and must possess the faculty of combining the attributes of the Master Mechanic and the Master of Men in the broadest meaning of both of these terms. He must act upon a basis of sound knowledge and scientific principles, without which he cannot handle the economic and psychological forces which must be brought into action, before results can be reached.

There is no doubt in my mind that the Institute can do this training, especially if it can succeed in bringing together engineers who are able to meet its standard, and are willing to co-operate to meet its high requirements, and who at the same time are willing, earnestly, to co-operate for the advancement of the vocation and the usefulness and the scope of the Institute as a developer of man, and a maker of useful plant workers and plant managers.

That the Institute is becoming recognized as an important factor in the training of young men for the vocation, is shown in the fact that the Williamson School of Mechanical Trades in Delaware County, Pa., has affiliated itself with the Institute in order to assist its young graduates to become members in the Craftsman grade of the Institute, and its class in Stationary Engineering is now called Operating Engineering. The Institute has placed, with its various members throughout the country every one of the Williamson School operating engineer graduates. I have 2 of these young men, and find them to be of the type that will make good as future Master Operating Engineers and Plant Managers.

We are living today in an age of applied mechanics, wherever a man goes he finds himself depending upon mechanical appliances and power distribution. He travels to and from his work by means of steam and electric machinery. Go down to the source of the energy applied for making possible the daily use of all the modern appliances now found in every walk of life, and we find that the operating engineer is behind that power that operates and controls it.

This is not said for the sake of flattering the Operating Engineer, but rather to call his attention to the kind of responsibility he must shoulder, and as a weighty reason why he should be prepared to meet this responsibility. It is said, in order to make him see that before he can conscientiously shoulder this responsibility of directing and controlling the forces of nature for the millions of unsuspecting users of it, he is in honor bound to be acquainted with the principles and the laws that govern these forces. We have too many men in the vocation who have no conception of what engineering responsibility means; their knowledge is limited to a few rules of thumb, the deriviation of which they do not know.

Many operating engineers will likely resent the plainness of speech used in this discussion, but the subject of the present day operating engineer's problem is one that needs plain and frank handling. The vocation is a comparatively new one and it has now reached a stage in its development that requires quick action if we wish to keep its highest positions open for the ambitious firemen and machinery operator, who works and studies in the hope that he may some day become a Master Operating Engineer.

But as the industrial exactions in demanding knowledge and training have become harder and harder to meet, the plant worker must persistently keep up with these demands if he wishes to make progress. The Institute of Operating Engineers is formed with the express idea in mind that concentration of effort and individual merit are those things most needed by members of the vocation in its present stage of development.

The representative operating engineer will, and ought to become the ideal teacher of Operating Engineering, and there is at once a great field for him, when it becomes known that he has the qualifications and attributes needed to be a teacher, and a safe guide for young men. There is a great cry among educators in charge of schools to get effective teachers.

The Institute of Operating Engineers can be of great and lasting economic value in inspiring handicapped men with new hope. To work for the principles of co-operation, and the Golden Rule, is a worthy task for each of us, and the Institute organization provides a chance for everyone. Nobody can say there is nothing he can do, for if he is of the right spirit, opportunities will be found and made for the working member who is doing with his might, what his hands find to do.

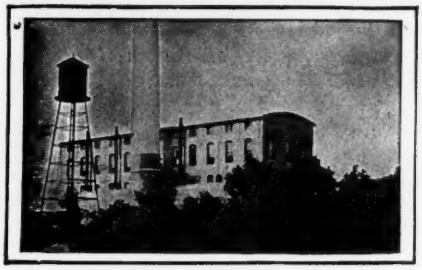
The Institute stands for the square deal to both employer and employe; it urges efficient training and friendly co-operation that will be a basis of good will and esteem.

There are 3 things which are the largest factors of success, not only in social, but in the industrial and commercial worlds, they are, ability, honesty to self, and friendship. The Institute in its function as a conserver, and a developer of man and man efficiency is the logical society for the young man to join. The older members give help to the younger ones, not with the idea of gain or credit, but simply in answer to the economic duty—Aiding in the making of efficient industrial workers.

Co-operation, the Institute motto, is the lever upon which the Institute depends in its work of carrying out the outlined program of apprenticeship and technical instruction.

Operating engineers and journeymen machinery operators are studying, as never before, the methods followed by successful men, and undertakings they wish to emulate. They have found that among the most successful manufacturing establishments the young man is taken in hand and given a thorough training, and that any one who persists in unwillingness to overcome ignorance and incompetency, can never hope for anything but a bare living. We have been forced, perhaps often unwillingly, to acknowledge that employers and apprentices have rights which cannot be ignored, one must be given efficient service, and the other efficient training, which means that the master operating engineer must be a capable business manager and a teacher as well. To help all parties in meeting this demand, is the aim of this Institute.

Sporadic efforts are not sufficient to compass the important work which is the aim of the Institute. How is the idea of progress, which is taking possession of so many of our men, to bear fruitful results, unless able and conservative leadership is secured in truly democratic fashion, as provided for by the Institute, the organization of which recognizes the fact that every individual unit, Employer, Engineer, Journeyman or Apprentice is dependent upon the others.



Power Apparatus

In Shop and Market

New Ideas in Making, Buying and Selling

THE SALESMAN'S ANGLE

IN an address before the National Gas & Gasoline Engines Trades Association last December, Charles O. Hamilton, general manager of the Elyria Gas Power Co., Elyria, Ohio, brought up the question of how much cost is justified in getting the completed product from the manufacturer to the user. Obviously it is necessary to pay transportation charges, but this is a small item as compared with the cost of selling in which is included finding the prospective user, calling his attention to the product, showing him what it can do for him and convincing him that he ought to buy it.

Mr. Hamilton in his paper has carefully analyzed how these different things are accomplished in the ordinary selling campaign. From his own experience and evidence of others, he concludes that getting in touch with the prospective user is accomplished either by advertising or by a salesman's discovering him, and that the latter method produces but few possibles.

Studying the cost of completing the sale by means of personal salesmanship, Mr. Hamilton has reached the conclusion that if the buyer, after having come in touch with the manufacturer, will only take sufficient interest to study carefully the facts that are placed before him and will then buy direct from the manufacturer without the need of expensive salesmanship, a very considerable part of the cost of manufactured products can be saved to the buyer.

In pamphlets recently sent out, one of them being "The Salesman's Angle," a reprint of the address already mentioned, these points are emphasized and gone into in detail. Mr. Hamilton shows that the functions of the salesman's discovering the man and pointing out the advantages of the gas engine are things that can well be done by advertising and by carefully prepared catalog literature.

Offering of engineering advice in regard to location, installation and operating can better be done by the engineering department at the factory if the buyer will only write in and state his conditions.

Extension of credit to a buyer, which might possibly be done by a jobber, is a banking proposition and can better be handled by a bank than by a manufacturer, and so far as the carrying of repair parts is concerned, better service can usually be had by dealing direct with the factory than through intermediate salesmen.

Another pamphlet, "The Awakening," is in dialog form and describes the meeting of prospective user and builder in the builder's factory. Here it is shown that the cost of the salesman's service, which, as argued above, can be as well if not better performed in some other way, is in the region of 20 per cent of the cost of the engine and that by a system which Mr. Hamilton is now adopting for marketing the "Little Big" engine, which his company makes, it will be possible to save this cost to the buyer.

The catalog of this engine is a new departure in gas engine literature. It tells actual facts, dimensions, performance, etc., in regard to the engine which it describes, furnishes information blanks which can be used in connection with correspondence, and which will place before the engineering department at the factory just what the user's requirements are and enables the manufacturer to quote a close price on the direct sale.

The series of pamphlets is interesting reading and anyone who wishes some real information in regard to gas engines will do well to go over these booklets carefully, whether he has immediate need of a gas engine or not. The plan is one looking toward the reduction of power costs and is well worthy of consideration and of the co-operation of the prospective buyer.

One of the causes of increased expense in doing business, as well as in maintaining households, is the high selling cost which attaches to our present methods. If this can be partly reduced it will cut down expenses all along the line and will help solve one of our national problems.

IMPROVED GAGE PRESSURE TUBES

IT is understood the action of pressure on a curved tube or spring in a gage forces the sides apart, resulting in a greater radius of curvature and consequent motion of the free end.

The principle of the helical form is the same, for it is, in effect, a series of curved tubes placed end to

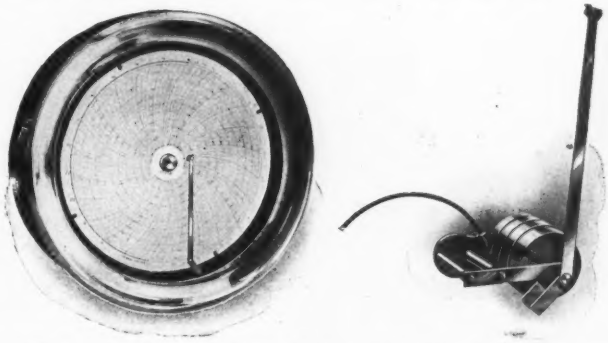


FIG. 1. IMPROVED PRESSURE GAGE AND DETAIL OF TUBE

end. Pressure applied causes the tube to untwist and the free end to move a distance proportional to the pressure applied. Helical forms of pressure tubes heretofore employed in recording gages have the pen arm attached directly to the free unsupported end. In the Industrial Helical Pressure Tube for pressure

above 6 lb., a simple but substantial support has been devised which supplies an axis of rotation, resulting in precise travel of the pen over a definite predetermined arc.

This support eliminates possibility of accident displacing the tube or disturbing the adjustment. The support gives the required protection and ruggedness.

For very minute pressures requiring reading in inches of water a series of diaphrams built up into the form of a bellows is employed. Application of pressure tends to elongate the tube, but this motion is converted into a multiplied lateral motion by means of restraining coils secured to one side of the tube. The motion thus obtained is transmitted through a

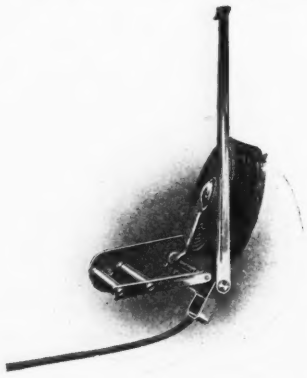


FIG. 2. BELLOWS FOR RECORDING GAGES

very simple and effective device to the pen arm in such a way as to produce a practically uniform scale throughout the range of the chart. Of importance, is the feature of support similar to that employed with helical pressure tubes. Used in conjunction with the diaphrams it contributes to a marked degree to positive action of the recorder, at the same time giving strength and stability and freedom from mechanical disturbance. Although designed for extreme sensitiveness and accuracy, the improved form insures great rigidity and durability under service. These instruments are marketed as part of a line of instruments to improve operating efficiency by the Industrial Instrument Co., Foxboro, Mass.

DETROIT THREE-WAY VALVE

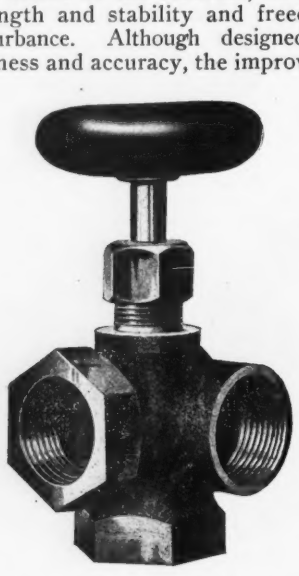
THIS valve which is used for water cooling systems on gas and gasoline engines is designed to turn the necessary amount of water into the water cooled muffler or exhaust after it has passed through the water jacket on the cylinder, turning the rest of the water overboard or to the sewer. The valve is so constructed that it permits any quantity of water being diverted into the muffler by a slight turn of the indexed valve handle. All the rest of the water is wasted to the discharge without further regulation.

It consists of a globular body with 3 openings, one at the base, through which the water enters, and 2 at right angles to each other on the 2 sides. The shell is so arranged that all the water coming up through the opening in the base can be turned through either one of the side openings or any part of it can be diverted through either of the openings and the rest sent through the other one. An index on the handle shows what portion of water is passing through each opening. The shell is conical in form and is held to its seat by a spring in the bonnet of the valve, thus taking up any wear. The globular form on the valve body prevents this conical shell from sticking because it comes in contact with only a small portion of the body at the top and bottom and along a narrow vertical strip on either side where a gate is formed for closing the water way. The valve is threaded for either ½ or ¾-in. It is made by the Detroit Lubricator Co., Detroit, Mich.

THE CADET OIL PUMP

DEMAND for a definite and reliable method of lubrication has led to the introduction of pumping devices for lubricating the cylinders of steam and other machinery, and this form is rapidly taking the place of hydrostatic methods as exemplified by the sight-feed lubricator.

The Powell Cadet mechanical oil pump has been designed and constructed as to deliver a certain quantity of oil into the cylinder with continued regularity and, being controlled by the movement of the part to which the arm K is attached this delivery is always under control.



THE DETROIT 3-WAY VALVE FOR WATER COOLING SYSTEMS

FIG. 1. FRONT VIEW OF THE CADET OIL PUMP

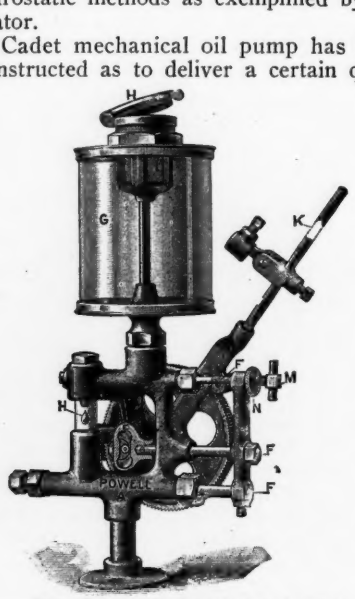


FIG. 2. REAR VIEW OF CADET OIL PUMP

The frame which carries the operating parts is cast of steam bronze composition sufficiently heavy to be durable under extreme service. The ratchet wheel B, pawls CC, eccentric and plungers FFF are of tool steel. The ratchet wheel teeth are milled cut and all steel parts are hardened.

Oil is poured into the glass reservoir G through the strainer H, which should at all times be kept clean. From the reservoir the oil flows by gravity to the top plunger chamber. This plunger forces it past an interior check valve, to the sight glass and then to the lower or delivery chamber, in which is located the delivery plunger. The delivery plunger forces the oil through a check valve and by its continuous action keeps the oil in motion to its final delivery to the steam pipe and thence to the cylinder.

Action of the plungers is automatically controlled by the speed of the engine, the power being received through the driving rod K, which operates the ratchet wheel by means of pawls CC engaging the teeth in the rim of the wheel B. This ratchet wheel is directly connected to the cam motion E, located between the upper and lower plunger, and gives a positive drive which increases or decreases according to the speed of the engine.

The driving rod K is connected to the eccentric rod, or some other moving part of the engine and the stroke is regulated by moving the stem connecting device up or down the rod. The ratchet wheel is provided with a handle which enables the engineer to force a greater quantity of oil to the cylinder as is often necessary when starting the engine.

The oil feed is regulated by screwing or unscrewing T handle M, which increases or decreases the number of drops. It is locked in position by the jam-nut. This regulation can be made while the pump is working, as the adjusting of the feed in no way interferes with the operation of the pump. The sight chamber always shows the quantity of oil being fed.

The advantages of the Powell Cadet mechanical oil pump are found in the automatic control of the lubrication. The hydrostatic method, as exemplified by the sight-feed lubricator, has a greater possibility of imperfect lubrication over an absolute method that is founded on a standard mechanical principle. In the sight-feed lubricator any slight fault that prevents the condensation of the steam also prevents the operation of the lubricator.

The oil drop, as delivered to the cylinder from the Powell Cadet mechanical oil pump, is in better form in comparison with that delivered by the sight-feed lubricator. Receiving force from the plunger of the pump it meets the force of the pressure of the steam when entering the steam pipe and is broken up into a fine spray that mixes intimately with the steam and lubricates all parts of the cylinder equally.

The normal oil feed is regulated when the pump is installed, but the action being automatically controlled by the speed of the engine through its connection with a moving part, speeds up or slows down as the load on the engine decreases or increases. This automatic control stops the flow of the oil immediately when the engine stops, thus being economical in consumption.

The Cadet pump works equally well on any type of engine whether high-speed or Corliss. There are no special parts required for connection, as it leaves the factory in complete form. It is made by the Wm. Powell Co. of Cincinnati, O.

THE S-C GAGE COCK

FIGURE 1 shows this in the closed position as it would ordinarily stand. It will be seen that a solid rod passes through the stuffing box into the body of the gage cock and that in the outer end of this rod is a passage which communicates with the nozzle. In the closed position, the solid rod extends through the packing and there is no possibility of leak. The rod is forced back to the open position, Fig. 2, by means of the lever with bell crank arm fitting into a notch in the nozzle rod. When this lever is pulled down, it forces the rod back, pushing the hole in the nozzle rod into the steam space in the body of the gage cock and opening up connection to atmosphere. As soon as the pull on the gage cock handle is released, the pressure of steam on the end of the nozzle rod forces the cock closed. This removes the hole from the boiler and makes all tight again. The packing used is metallic, and is therefore permanent. The hole stands outside the boiler so that it can be cleaned at any time necessary, and there is no possibility for wear of any parts of the valve. This cock is made by the S-C Regulator Co., Fostoria, Ohio.

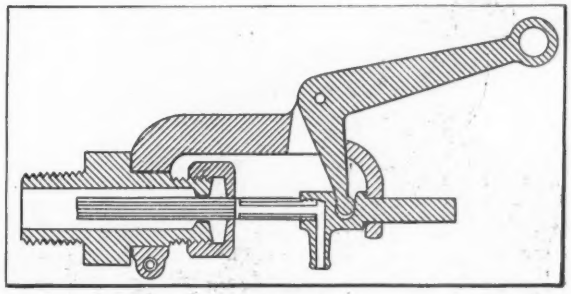


FIG. 1. THE S.-C. GAGE COCK CLOSED

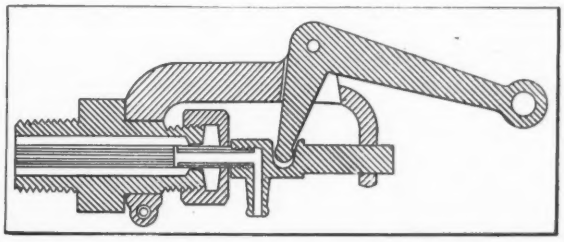


FIG. 2. S.-C. COCK IN OPEN POSITION

CYLINDER LUBRICATION BY A NEW SYSTEM

USE of the steam indicator has now become so common among engineers that most every one realizes that of the power shown by indicator cards, anywhere from 3 to 20 per cent never reaches the shaft. A moment's thought will show that practically all this lost power is due to friction of the piston rings and valves and also to a slight extent to that in the bearings.

In the majority of engines, bearing lubrication is amply provided for, but the question of cylinder lubrication is not usually so well taken care of; in fact, proper lubrication of steam cylinders is one of the

most difficult troubles that the power plant engineer has to meet.

Cylinder lubrication is usually applied by the ordinary type of hydrostatic lubricator or by means of force feed lubricators, both of which mix drops of oil at stated intervals, with the entering of steam. In

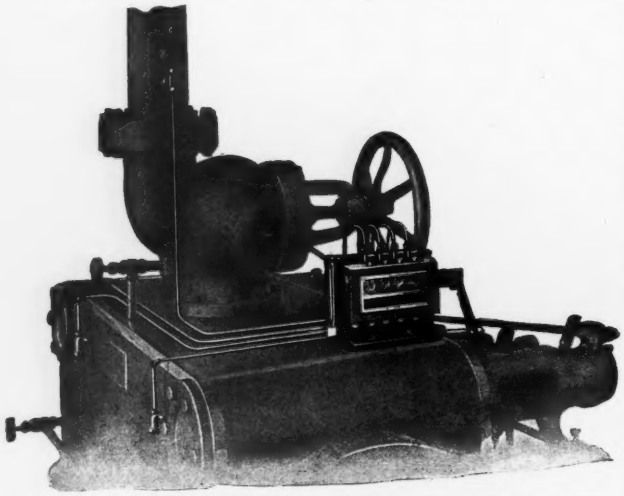


FIG. 1. APPLICATION OF RICHARDSON LUBRICATOR TO FEED OIL TO CYLINDER, VALVES AND RODS

some cases where force feed lubricators are installed, extra feeds are provided for injecting oil under valve seats, on metallic piston rod packing, etc. Such an application of a Richards Lubricator is shown in Fig. 1.

If with the ordinary force feed 4 drops of oil per minute are fed to the steam entering the cylinder, and the engine is run at 200 r.p.m., each large drop of oil will, in a measure, be broken up and atomized with the steam, but a considerable portion of it will pass out with the exhaust, without having effected lubrication, and the next 100 strokes will be unlubricated.

it might be stated that in one of the largest pumping stations in the country the first 6 pumping engines installed were equipped with other force feed lubricators; later 6 additional engines were installed, each equipped with a 6-feed Richardson lubricator. It was apparent to the engineers in charge that the latter group of engines were consuming much less oil than the former, so that a 60-day test was made. First one of the older pumping units was run 30 days with the ordinary lubricator, then this was replaced and a 30-days' test made on the same engine equipped with a Richardson lubricator, and it was found that the Richardson reduced the oil consumption 33 1/3 per cent and at the same time increased the engine efficiency.

In order to accomplish this system of feeding some oil at every stroke of the engine, the lubricator employs an oil pump plunger for every feed line, and no matter at what rate the oil is being fed through the sight feed nozzle of the lubricator, this oil plunger moves up and down in unison with the strokes of the engine, chops off a small particle of oil and forces it to the cylinder at each revolution of the engine.

Design and operation of the Richardson lubricator will be made clear by referring to Fig. 2, in which the travel of the oil from the main reservoir to the outlet feeds is indicated by arrows. The oil is drawn from the reservoir through foot valve A, by means of plunger B, delivering the oil through circulating channel C into which are connected the adjustable needle valves MMM, for regulating the feed of oil through each drip nozzle R.

Surplus oil not passed through the feed valves returns to the reservoir, through overflow ball check D. The slight gravity head on each drip nozzle is constant, so that the oil flows drop by drop at any de-

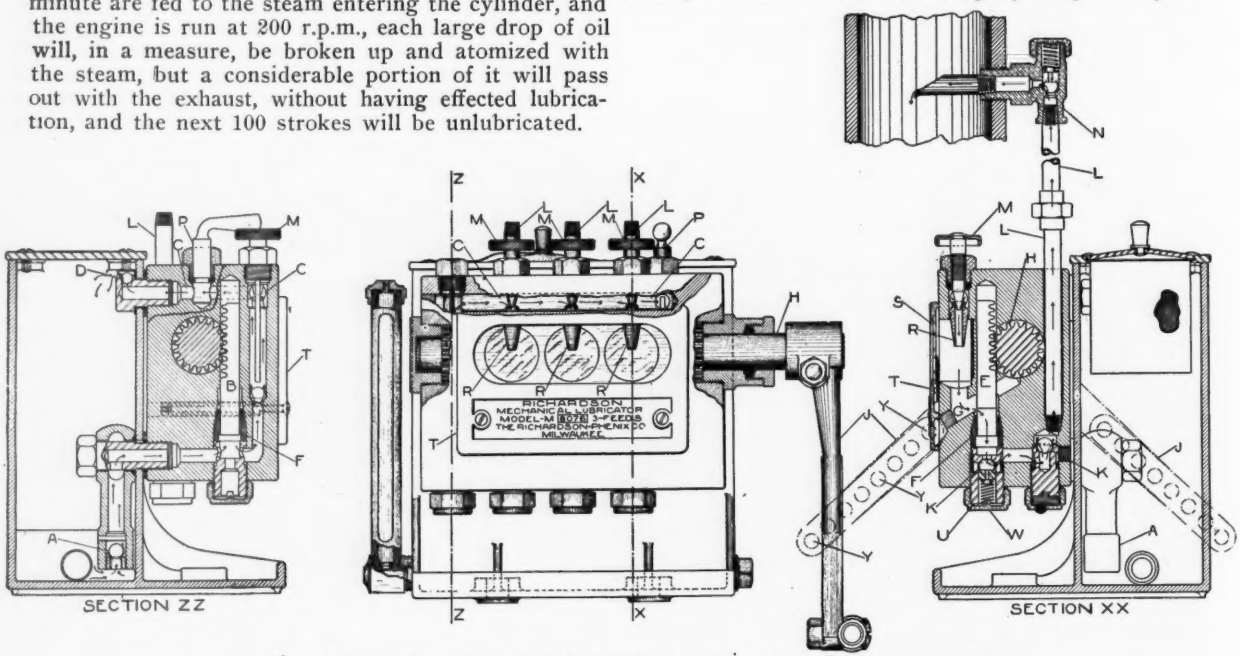


FIG. 2. FRONT VIEW AND SECTIONS OF THE RICHARDSON 3-FEED LUBRICATOR

To meet this difficulty, the Richardson lubricator was designed, with the special object in view of introducing some oil for every stroke of the engine. To illustrate how well it accomplishes its purpose and to what extent this system of lubrication is effective,

sired rate, into the chamber G. Plungers E, one for each individual feed line, are actuated by a common gear shaft H, from the driving lever. These plungers move up and down with every revolution of the engine and at each downward stroke chop off a small

particle of the oil lying in each chamber G and force them out through check valves KK and on into the feed lines L.

Feed lines are always full of oil up to the check valve N located at the point of delivery; thus every time the pump plungers come down they force a small particle of oil into the line, liberating a corresponding amount at the terminal check valve. As the oil is forced through 2 check valves KK and terminal check valve N, there is no liability of pressure from steam backing up into the lubricator. The check valves are of a special steel ball type, held in place on a bronze seat, by a coil spring under a hexagon nut.

A very important feature is the increased feed valve P located in the oil circulating channel C. This valve is normally left open, but should there be a temporary demand for increasing the amount of oil fed, it can be closed, shutting off the return to the reservoir and causing all the oil delivered by the circulating plunger to flow through the feed nozzles RR, etc., temporarily forcing the flow of all feeds. When the increased demand has been met, the increased feed valve P is opened. Thus the adjustment of the needle valves M need never be changed, to meet a temporary demand for additional oil.

Driving lever J requires a reciprocating movement of from 72 to 96 deg., and can be moved into any position on the shaft. The necessary travel of the lever J can be adjusted by attaching the driving rod in any one of the 8 wristpin holes Y, this permitting any straight across travel from 3 7/16 to 8½ in.

The glass S protecting the feed nozzles R is not under pressure, being held in position by a spring retained brass frame, which can be easily tipped forward for cleaning.

The Richardson lubricator can be had with any number of feeds and with subdivided tank, if so desired for handling 2 or 3 different kinds of oil, as, for instance, the 22 feed lubricator handles 3 kinds of oil, for lubricating the cylinders of steam engines, air compressors, refrigerating machines, etc.; this ability to handle several kinds of oil is a great advantage.

The Richardson system is made by the Richardson-Phenix Co., Milwaukee, Wis.

DEATH OF C. W. HUNT

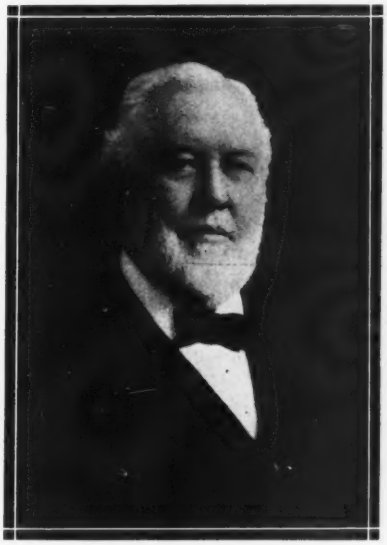
CHARLES W. HUNT, president of the C. W. Hunt Co. of Staten Island and of the McCaslin Machine Co., also a Staten Island concern, died on Monday morning, March 27, at his residence on Grymes Hill.

Mr. Hunt was born in 1840, at Candor, Tioga County, New York. He went to Staten Island shortly after the Civil War and engaged in the retail coal business in West New Brighton, and was a resident of Richmond County from that time until his death.

While in the coal business he became interested in the problem of cheapening and improving the handling of coal and other bulk materials. The result of his investigations was a number of inventions of automatic machines, cars and tramways, that revolutionized coal handling methods, and made simple and comparatively unexpensive the handling of all bulk materials.

In the early seventies he built his factory in West New Brighton and began manufacturing his inventions, and in the succeeding years developed and built up the great institution now operated by his company.

Among the many great enterprises planned and executed by Mr. Hunt were the government coaling stations at Manila and Puget Sound, also a number



CHARLES W. HUNT

of great coal handling plants in the United Kingdom and on the Continent were built by the C. W. Hunt Company.

Mr. Hunt was a member of several fraternal orders and was vice-president of the Richmond County Savings Bank, of West New Brighton. He was a member and served as president and vice-president of the American Society of Mechanical Engineers. He was also a member of the American Association for the Advancement of Science, the Musical Art Society, Franklin Institute, New York Electrical Engineers Society, New York and Staten Island Chamber of Commerce and the Hardware, Machinery and Staten Island Clubs.

Mr. Hunt was a son of William Walter and Elizabeth Bush (Sackett) Hunt. He was educated in the Cortland Academy, at Homer, New York. He married, in Candor, in 1868, Frances Martha Bush, who died at West New Brighton; and at Ithaca, New York, in 1889, he married Miss Katherine Humphrey, who survives him. He also leaves four children, William Floyd, Frances Helen, Charles Wallace, Jr., and Mary Eloise Hunt.

Mr. Hunt was a man of great ability, of unsullied character, sterling integrity, and was a credit and honor to the country in which he lived. His death is a distinct loss to Staten Island, and he will be mourned by hundreds of people, who will miss his kindly and charitable acts in the years to come. He was always ready to lend a helping hand to the poor and unfortunate, and all who were privileged to bear his acquaintance will ever honor and respect his memory.

THE PERCENTAGE OF DENSITY of smoke is the percentage of light that is prevented from passing through it. Using the Ringlemann charts, No. 1 smoke represents 20 per cent density; No. 2, 40 per cent; No. 3, 60 per cent; No. 4, 80 per cent, and No. 5 is opaque and therefore represents 100 per cent density.

NEWS NOTES

THE FORT WAYNE ELECTRIC & MFG. CO. is erecting a new factory building which will be 250 ft. square and 4 stories high and will increase the floor space of its factory by 75 per cent. Adjoining this building will be the general office building, 250 ft. by 80 ft., and 5 stories high. The buildings will be made of structural steel and pressed brick, the office being trimmed with white marble.

MANY CANADIANS, particularly old McGill University boys, will be interested to know that F. L. W. Saunderson has been appointed the Canadian manager of the Magnolia Metal Co., with factory and offices located in Montreal. Mr. Saunderson graduated at McGill University in Class of 1891, taking a course in Electrical Engineering and afterwards took a special practical electrical course with the Thomson-Houston Electric Co. at Lynn, Mass., and for the past 15 yr. has been identified with the mill supply business in Canada. He enters upon his new duties well equipped to insure that the interests entrusted to him will be well cared for and advanced. Mr. Saunderson is widely known and prominently connected throughout the Dominion; his father, C. E. Saunderson, prior to his decease, was senior partner in the Montreal firm of B. & S. H. Thompson; and his brother, A. O. Saunderson, is at the head of the Saunderson Mfg. Co., of Sydney, N. S.

C. H. PEARSON, formerly with the Noera Mfg. Co., of Waterbury, Conn., has taken a position in the hoist department of the Yale & Towne Mfg. Co. and will be located in the Western department of the company's organization.

THE NATIONAL GAS & GASOLINE ENGINE Trades Association convention is to be held in Detroit, June 20-23. Meetings will be held at Hotel Pontchartrain, the session of June 20 being devoted to announcements of committees, appointments, reports of officers and short speeches. In the afternoon the marine engine committee will report and a paper will be read on the Relation of Ignition to Sales Department, by R. H. Combs. The evening will be left for visitors to fill at their own pleasure. Wednesday morning, June 21, the agricultural committee will make report and 2 or 3 good papers will be presented on the subject. Wednesday afternoon will be spent in a trip on one of the lake steamers to a shore resort, returning to the city in the evening. On Thursday the morning session will be taken up with business and with professional papers. The afternoon will be devoted to an address by E. St. Elmo Lewis on Advertising and Business Management. Other prominent speakers from the automobile industry will be arranged for. On Friday, the 23rd, trips will be planned to a number of the automobile engine and other factories in Detroit.

THE NEW OFFICE of the Elliott Co. and of the Liberty Mfg. Co. in Boston is located in the Oliver Building, Room 954. This has three entrances, one at 141 Milk St., another at 8 Oliver St. and a third at 45 Battery March Street. Herbert E. Stone is in charge of the office and handles the business in the Boston territory.

DAVID M. MYERS has moved his consulting practice to larger offices in the new Whitehall Building, 17 Battery Place, New York City, and will continue his special service on the fuel problem.

THE RICHARDSON-PHENIX CO., in order to care for its constantly increasing business in the Pittsburg district, has opened an office in the Keystone Building, 324 Fourth Ave., Pittsburg, under the management of H. H. Laughlin, for several years with the Richardson-Phenix Co. Mr. Laughlin is familiar with all systems of lubrication and will be glad to give personal attention to all inquiries in regard to lubricating any kind of machinery or plant.

ANNOUNCEMENT IS MADE of the purchase by the Nashua Machine Co., of Nashua, N. H., of the Bundy Steam Trap business of the American Radiator Co., effective May 1, 1911.

THE LUNKENHEIMER CO. has recently opened a new branch store at 138 High Street, Boston, where it is carrying a full line of Lunkenheimer high grade engineering specialties, consisting of brass, iron, "puddled" semi-steel and "crucible" cast steel globe, angle, cross, pop, safety, blow-off, check, gate and non-return boiler stop valves; whistles, injectors and ejectors; cocks, oil and grease cups; lubricators, oiling devices, oil pumps; water columns and gages, automatic and motor boat specialties. Wm. W. Beal is in charge of the store, which occupies a prominent corner on High Street, and the windows present an attractive display of the various specialties made by The Lunkenheimer Co. The general offices and works of the company are located in Cincinnati, Ohio.

T. W. SNOW, former president of the Otto Gas Engine Co., announces the formation of a new company to be called the T. W. Snow Construction Co., with offices in the Ellsworth Building, Chicago. Mr. Snow will construct water stations, coaling stations, water softening plants, power plants and the entire line that he has been handling during the past twelve years.

RECENT MEETINGS of the Institute of Operating Engineers are reported as follows: On Thursday evening, April 13, J. C. Jurgensen delivered his paper on "Economic Aspects of the Institute of Operating Engineers," before the New York Branch, in the Engineering Societies' building. The meeting was well attended. Some 70 members and friends being present. The paper was well received and thoroughly discussed by the members and those present.

On Saturday evening, March 25, the members of the Institute living on Long Island, met at the rooms of the Modern Science Club and organized the Isherwood Branch No. 2 of District No. 2. Officers elected were: F. L. Johnson, chairman, and Frank Martin, secretary-treasurer. This branch starts out under extremely favorable circumstances as it is made up largely of the men interested in the education at the Modern Science Club during the past winter. This class has been very successful and the members of it are enthusiastic over the results as far as they have gone.

On Thursday evening, May 11, at 8 o'clock, the second monthly meeting of the New York Branch of the Institute of Operating Engineers will be held in the Engineering building. F. L. Johnson will deliver a paper on the "Necessity for Industrial Education." There will be a discussion of the paper.

At the last meeting of the executive committee of the Institute of Operating Engineers, Hubert E. Collins was elected secretary in place of M. W. Rice, resigned.

W. P. F. Hill was elected treasurer in place of Adam Harkness, whose term had expired.

On Tuesday, April 11, A. Bement spoke on Coal and Coal Mining before T. J. Waters Branch of Chicago of the Institute of Operating Engineers in the rooms of the W. S. E., Monadnock block. The different methods of mining and grading coals were explained and illustrated by lantern slides, and the extent and values of the Illinois fields outlined.

CATALOG NOTES

THE LATEST GASKET is the title of a catalog issued by the Cincinnati Gasket & Packing Co., Cincinnati, Ohio, describing 2 styles, the Trinity and the Triple. The booklet shows the different styles made, their construction, the different shapes kept in stock, and the prices.

IN BULLETIN 4618 just issued by the General Electric Co. is described the new Form P. B. polyphase generator for use in small power plants and isolated lighting plants where rapidly increasing inductive loads, and consequently low power factors, are encountered. The bulletin contains a full description together with weights and dimensions.

In Bulletin No. 4815, issued by the General Electric Company, are illustrated and described continuous and alternating current motors, and apparatus for controlling them when applied to machine tool operation. The publication contains also illustrations of the motors installed on drills, saws, shapers, milling machines, slotters, planers, lathes, etc.

NEW BULLETIN No. 131, which is a 44-page illustrated catalog of Bristol's Recording Voltmeters for switchboard and portable service with 12, 8 and 6-in. charts, contains a full description of these instruments. This bulletin also includes a partial list of about 1000 users of Bristol's Recording Voltmeters with the names of many of the most prominent electrical power and lighting corporations and manufacturing concerns in the United States and elsewhere.

FROM THE PEERLESS RUBBER MFG. CO. comes an interesting folder describing the different packings, gaskets, rings and belting made by the company. There are listed also the various kinds of hose, mats, rubber tiling, etc., which are described at length in the company's large catalog.

FROM THE LIBERTY MFG. CO., of Pittsburg, Pa., has been received a new catalog describing the Liberty Tube Cleaners and other tools. This shows clearly the construction of the different types of Heavy Duty Cleaners with various heads for attacking scale of different kinds, the Liberty Standard Cleaner for large and small tubes, the Niagara Cleaner with turbine motor, the Bull-Dog turbine driven cleaner for light scale when equipped with the No-rivet head, and for heavy scale when equipped with the extra heavy Universal Joint and Drill, the Cyclone Air Driven Cleaner, the Rotocentric Cleaner, which works on the principle of a rotary engine, and the details of different types of heads for different weights and conditions of scale.

BULLETIN NO. 120 received from the American District Steam Co., of Lockport, N. Y., treats of factors that affect the cost of generating and distributing steam for heating. It is a reprint of a paper read by Chas. R. Bishop before the National District Heating Association and contains, besides discussion of the important points in looking after a central heating plant such as keeping tubes and piping system clear of scale, guarding against leakage, metering the steam supplied, etc., a fine system of record blanks for keeping track of just what the costs have been for operating the plant, the heating service that has been rendered and the efficiency of operation. The blanks and system of keeping records will be found worthy of careful study by everyone who has to do with a heating plant, whether it be a central heating system or heating of a single plant.

TRADE NOTES

TO THE CLING-SURFACE CO. of Buffalo, N. Y., has recently come an interesting postal dated at the Bharat Abhyuday Cotton Mills, Gooshery Rd., Talkia P. O., Hawrah, India.

"Kindly send a copy of your 'Belt Book' free as advertised in the 'Practical Engineer' of January, 1911. I have used and am using Cling-Surface, buying it from local market and found to give me entire satisfaction. I hope you will favor me with a copy of the above book, and oblige, Yours faithfully, N. N. Bava-adam, Engineer."

ALBANY LUBRICATING CO. was founded in Albany, N. Y., in 1868, and not in Troy, as stated in the April issue.

THROUGH AN AGREEMENT entered into between the International Acheson Graphite Co. and the Acheson Oildag Co., the first named company on April 1st became general agents in the United States for the sale of the new lubricants, Oildag and Aquadag, products of the second named company. This means that the trade will in the future be supplied with Oildag and Aquadag by the International Acheson Graphite Co. of Niagara Falls, N. Y., which places this company in touch with the sale of lubricants that meet any and all needs, inasmuch as the company itself makes Gredag, a lubricant which contains Disintegrated Acheson-Graphite and grease, while Oildag is Deflocculated Acheson-Graphite and oil, and Aquadag is Deflocculated Acheson-Graphite and water. All Acheson-Graphite is made in the electric furnace, the production of Acheson-Graphite last year being over 13,000,000 lb.

HAVING PROVED the popularity of its fan motors using alternating current, the Ft. Wayne Electric & Mfg. Co. is preparing for a large demand this season. These motors have wound rotors and short circuited secondaries or stators. The motors will start automatically and are built for 5, 8, 12 and 16-in. fans. Somewhat of a specialty has been made by this company of installations on farms where 35 volt tungsten lamps are employed for lighting, the motive power for generating the current being supplied in most cases by gasoline engines.

A. W. FRANCE, of Tacony, Philadelphia, reports that his air lift system for pumping water is meeting with gratifying success and that the special foot piece which enables a saving of 35 to 50 per cent in air used, greatly reduces cost of operation as well as size of air compressor needed for any given plant.

CORRECTION NOTE

The Magnolia Metal Co. point out an error that was made in its April advertisement by the misplacement of a decimal, which has an important bearing upon the figures shown in the table under heading of "Coefficient of Friction—"A" White Brass—in the test by the United States Government, using water as a lubricant. The figures under this heading should read as follows:

Magnolia No. 1	0.00159375
Magnolia No. 2	0.0049479
"A" White Brass	0.0198916
Magnolia No. 1	0.00080208
Magnolja No. 1	0.00129166
Magnolia No. 1	0.002427
Magnolia No. 1	0.00275

PRACTICAL ENGINEER CLASSIFIED ADVERTISEMENTS

Advertisements in this section are inserted under regular headings at the rates of 40 cents per line. About nine words make a line. No display type allowed, but the first three words may be set in capital letters. Minimum space sold, two lines.

Under classification, "Positions Wanted," advertisements not exceeding four lines will be inserted for subscribers once free of charge.

To insure proper classification, copy must reach this office on or before the 20th of month preceding publication.

Positions Wanted

POSITION WANTED—As electrician or assistant engineer in manufacturing or hotel plant. American young man, 30, honest, reliable, sober, wants offer. First-class references. 12 years' experience central stations and isolated plants, A. C. and D. C. apparatus, steam engines and turbines, interior wiring and construction. Give full particulars and address Box 171, Practical Engineer, Chicago. 5-1

POSITION WANTED—By young man as assistant or oiler in engine room. Have completed steam engineering course in I. C. S. Age 20. Moral habits and industrious, some experience. Give full particulars. Address Clement E. Benham, Box 181, Soldier, Blaine Co., Idaho. 5-1

POSITION WANTED—Young man experienced in construction and maintenance, hoisting, conveying and handling machinery desires permanent connection or erecting work. Good labor handler. Sober. References. Address Box 169, Practical Engineer, Chicago, Ill. 5-1

POSITION WANTED—By young married man 21 years of age, around a steam power plant. Have I. C. S. education and twelve months' experience. Please state full details in first letter. Address Box 170, Practical Engineer, Chicago. 5-1

POSITION WANTED—As engineer in power or manufacturing plant; experienced with all kinds of engines and boilers; references. Address Box 165, Practical Engineer, Chicago, Ill. 5-1

POSITION WANTED—Young man 25 years of age would like position as engineer in small plant; have had experience in ice plant and also have run steam roller; good habits. Address M. Hughson, Shelby, Mich. 5-1

POSITION WANTED—Young man 23 years of age would like position as engineer. Four years' experience with steam plant. Can come at once. Address Charles Ferris, 23 N. Grove St., Grand Rapids, Mich. 5-1

POSITION WANTED—As fireman or assistant engineer in small stationary plant or somewhere around machinery; 3 years' experience on a dredge boat; good habits. Address Box 163, Practical Engineer, Chicago, Ill. 5-1

Help Wanted

WANTED—POWER EQUIPMENT SALES MANAGER by a power plant equipment manufacturing concern, an assistant sales manager, having technical education, practical motive power experience, and demonstrated capacity for organization, correspondence and sales getting. Address in confidence with full particulars, including salary expected. Employers Service Agency, 170 Broadway, New York. 5-1

AGENTS WANTED—TO SELL lubricating oils, belts, hose, paint, varnish, to factories, mills, stores, threshers; exclusive territory to right party; experience unnecessary. Manufacturers Oil and Grease Co., Cleveland, Ohio. 4-3

ENGINEERS AND MECHANICS—To make big money selling Incomparable "ZIZ" Hand Soap. A 10-cent can will instantly remove more dirt and stains from the hands than four cakes of any soap made, and it will not injure the most delicate skin. Small sample free. Byram Mfg. Co., Box 3133, Boston, Mass. 4-tf

WANTED—ONE ENGINEER in every town and city, to represent me, good money-making proposition. Write me. W. R. DuMond, 39 South St., New York. 5-1

ENGINEERS AND SALESMEN—You have acquaintances to whom you can sell "Allan's Boiler Compound." A surprisingly liberal commission allowed on sales or information which results in sales. Write for prices and particulars. A. C. Allan & Co., 628 W. 61st Place, Chicago, Ill. 5-1

COMPETENT AND EXPERIENCED stoker erectors at once. State age, experience, reference and salary expected. Give full details. Address Box 168, Practical Engineer, Chicago, Ill. tf

WANTED—A SALESMAN FOR the Chicago and surrounding territory to handle our line of power plant specialties on liberal commission basis. Address Box 164 Practical Engineer, Chicago, Ill.

HIGH GRADE SALESMAN WANTED by prominent manufacturer of piping, equipment of every description, valves, fittings, flanges, etc. This is an unusual opportunity for an aggressive, capable salesman whose selling experience has been along the line of high pressure power plant installations, but all applicants will be considered. Give age and full account of experience in first letter. Address Box 161, Practical Engineer, Chicago, Ill.

Wanted

WANTED—5,000 STATIONARY ENGINEERS to send us their name and address. A good proposition open to each one. For full particulars, write Henry W. Lord, 7 S. Greene St., Baltimore, Md. tf

For Sale

FOR SALE—$1.50 WILL BUY COMPLETE set of castings and all material for a neatly designed automatic steam engine of 1/16 H.P. Engine has rotary valve with adjustment for wear. Blue prints and instruction sheets, 25c. Complete engine ready to run, $6.00. Dept. D, Elgin Wheel & Engine Co., Elgin, Ill. 5-1

Patents and Patent Attorneys

PATENTS—WANTED, IDEAS—Manufacturers are writing for patents procured by me. Send for free 72-page guide book and list 200 inventions wanted. R. B. Owen, Dept. 28, Washington, D. C. 3-3

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 608 F St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had and the exact cost. Send for full information. 10-tf

PATENTS—C. L. Parker, late Examiner U. S. Patent Office, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the inventors. Handbook for investors sent upon request. 186 McGill building, Washington, D. C. 4-tf

Educational and Instruction

TECHNICAL BOOKS—Correspondence School sets, steam, electrical, mechanical, cyclopedias, reference works, charts, and all subjects of technical work. New—second-hand—cheap. Get my price before buying. George F. Williams, Box 408, New Orleans, La. 5-1

Miscellaneous

SUBSCRIBE NOW for the 1911 issue of the Stationary Engineers' Directory of the city of Philadelphia; $5 per copy. Mail checks to Stationary Engineers' Club, 1108 Arch street, Philadelphia, Pa. 5-2

EVERY ENGINEER should be posted regarding the new system of vacuum heating installed without payment of royalty; I have valuable information; write today. T. L. Reeder, 1413 W. Jackson Blvd., Chicago, Ill.